UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF CALIFORNIA
SAN DIEGO DIVISION

ODYSSEY WIRELESS, INC., Plaintiff, v. APPLE INC., Defendant.	Case No. 3:15-CV-01735-H-RBB **DECLARATION OF ANTHONY ACAMPORA, PH.D. REGARDING CLAIM CONSTRUCTION**
ODYSSEY WIRELESS, INC., Plaintiff, v. SAMSUNG ELECTRONICS CO., LTD, et al., Defendants.	Case No. 3:15-cv-01738-H-RBB
ODYSSEY WIRELESS, INC., Plaintiff, v. MOTOROLA MOBILITY LLC, Defendant.	Case No. 3:15-cv-01741-H-RBB

ODYSSEY WIRELESS, INC., Plaintiff, v. LG ELECTRONICS, INC., et al., Defendants.	Case No. 3:15-cv-01743-H-RBB

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L. "selecting a frequency interval over which a waveform U(nT) is to exist; wherein n denotes a discrete time index and wherein n=1, 2, ... , N; allowing at least one frequency that is included in the selected frequency interval to provide a frequency content to the waveform U(nT); excluding at least one frequency that is included in the selected frequency interval from providing a frequency content to the waveform U(nT); forming the waveform U(nT) comprising a plurality of elements U(T), U(2T), ... , U(NT), corresponding to respective integer values 1, 2, ... , N of the discrete time index n" and related terms (Terms 5, 7) – '230 and '837 Patents 85

I, Anthony Acampora, provide the following declaration regarding claim construction.

I. BACKGROUND AND QUALIFICATIONS

1. I received my Bachelor of Science, Master of Science, and Doctor of Philosophy degrees, all in Electrical Engineering, from the Polytechnic Institute of Brooklyn in 1968, 1970, and 1973, respectively. Both my Master's thesis and my Ph.D. dissertation involved theoretical aspects of electromagnetic wave propagation in plasma and gaseous media. From June 1968 through September 1988, I was employed at AT&T Bell Laboratories in various engineering, research, and managerial positions, all in the general area of telecommunications.

2. My initial work at Bell Laboratories (1968-1974) involved high power radar design and development, and signal design and processing for extraction of pertinent information from radar target returns, both focused on anti-ballistic missile defense applications.

3. My next assignment at Bell Laboratories (1974-1981) was in the Radio Research Laboratory, where I was involved in new discovery and proposals involving novel approaches for communication satellite systems. My contributions included (1) strategies to efficiently encode and recover digital information sent to and from the satellites via high capacity radio beams; (2) novel systems and on-board satellite switching approaches that use multiple radio beams (so-called spot beams); (3) strategies to acquire and maintain synchronization of radio signals sent to and from a satellite; and (4) a approach to overcome the effects of rain-induced attenuation of the radio beams that dynamically assigns available radio resources to those spots on Earth where rain attenuation is instantaneously most severe.

4. I was promoted to Supervisor of the Data Theory Group at Bell Laboratories in 1981, with responsibility for exploratory development of local area data networks.

5. In 1984, I was promoted to Head of the Network Systems Research Department (one of several departments within the Radio Research Laboratory, later to become the Communications Systems Research Laboratory, at Bell Laboratories) with responsibility for new architectures for packet switching and multiwavelength optical networks, wireless networks for broadband local access, and integrated voice/data wireless networks. Contributions included (1) a system architecture for using a raster of focused radio beams to deliver broadband service to a large number of buildings from a central location within a city; (2) a novel packet switching architecture for Internet-like wide area packet networks; and (3) a wide area multimedia networking strategy to enable access to the enormous information-bearing capacity potential of optical fiber cabling.

6. I was promoted to Director of the Transmission Technology Laboratory in 1987, a group of approximately 80 people with broad charter for exploratory development of (1) transmission and switching systems for next-generation Internet-like packet-based networks and (2) applications for digital signal processing in telecommunications.

7. I left AT&T Bell Laboratories in September 1988 to become Professor of Electrical Engineering and Director of the Center for Telecommunications Research at Columbia University. Here, my responsibilities were threefold: (1) teaching students about the field of telecommunications, (2) conducting independent research in the area of telecommunications, and (3) management of a National Science Foundation Engineering Research Center devoted to many aspects of telecommunications and founded for the express purpose of improving American economic competitiveness. Research programs at the Center for Telecommunications Research were focused on multiwavelength fiber optical networks, wireless communications, image and video communications, network management and control, and underlying photonic and electronic devices and materials.

8. In August 1995, I left Columbia University to become Professor of Electrical and Computer Engineering and Director of the Center for Wireless Communications at the University of California, San Diego (UCSD). Again, my responsibilities were threefold: (1) teaching students about the field of wireless communications, (2) conducting independent research in the area of wireless communications, and (3) management of an industrially funded research center devoted to wireless communications. Contributions included (1) strategies for allowing the use of so-called "smart" antennas in cellular-based packet radio networks; (2) a proposal for a new city-wide network based on a wireless mesh-based approach using either focused wireless beams of light or focused radio beams, intended to deliver broadband services to buildings and/or to connect wireless radio cells with the world-wide fiber-optic backbone network; and (3) mobility management strategies for high speed packet-based wireless networks. The second of these contributions has served as the technical foundation for at least two new venture-backed telecommunications equipment companies, one of which I co-founded.

9. In December 1999, I resigned as Director of the Center for Wireless Communications to pursue full-time research and education as a Professor of Electrical and Computer Engineering at UCSD and on January 1, 2008, I became Professor of Electrical and Computer Engineering, Emeritus.

10. At UCSD, I have taught courses on (1) probability, (2) random processes, and (3) wireless networks. My current research is focused on (1) broadband wireless networks for local access to homes, schools, and businesses; (2) wireless spaces to enable ubiquitous voice, data, and video wireless communications within buildings, and (3) so-called ad-hoc (self-organizing) networks of wireless sensor nodes for business and homeland security applications.

11. Over the course of my career, I have published (individually or with collaborators) over 170 original papers in scholarly journals and professional

conference proceedings, and I am the named inventor or co-inventor on 40 U.S. patents.

12. I am also the author of one of the first textbooks devoted to broadband telecommunications, entitled An Introduction to Broadband Networks. I have lectured extensively on telecommunications and wireless communications, and I have regularly attended, and continue to attend, world-wide professional conferences. I have chaired several telecommunications conferences, and I have chaired numerous professional conference technical sessions. Over the years, I have delivered many 3 to 5 day intensive short courses on telecommunications and wireless communications to professional audiences of practicing engineers and others. In 1988, I was elected to the grade of Fellow of the Institute of Electrical and Electronics Engineers, cited for contributions to high capacity digital satellite systems and broadband local communication networks.

13. I have been retained by Apple and am being compensated at my normal hourly rate of $725 per hour. My compensation is in no way contingent on the outcome of this case. My resume is attached as Exhibit B. In the past four years, I have testified at trial or in deposition in the cases listed on Exhibit C.

II. ASSIGNMENT

14. I have been asked by Apple to provide my opinions as set forth below. In particular, I have been asked to consider and provide opinions on how a person of ordinary skill in the art would interpret certain disputed claim terms in the patents asserted in this case.

15. I reserve the right to supplement this declaration to rebut any opinion, statement, evidence, or position taken by Odyssey in its claim construction submissions.

III. MATERIALS CONSIDERED

16. In reaching the opinions addressed in this declaration, I have

considered the following materials:

- The patents-in-suit: U.S. Patent Nos. 7,881,393 ("'393 patent"); 8,199,837 ("'837 patent"); 8,576,940 ("'940 patent"); 8,660,169 ("'169 patent"); 8,855,230 ("'230 patent"); and 8,879,606 ("'606 patent").
- The prosecution histories of the patents-in-suit.
- The provisional applications listed as related applications by the patents-in-suit: U.S. Provisional Application Nos. 60/692,932 ("'932 application" or the "June 2005 provisional application"); 60/698,247 ("'247 application" or the "July 2005 provisional application"); and 61/033,114 ("'114 application" or the "March 2008 provisional application").
- The prosecution histories of the non-provisional applications listed as related applications by the patents-in-suit: U.S. Application Serial No. 11/720,115 ("'115 application"); 12/372,354 ("'354 application"); 13/011,451 ("'451 application"); and 14/187,899 ("'899 application").
- The following references cited during the prosecution histories of the non-provisional applications noted above: Gorokhov, MIMO Transmission System in a Radio Communications Network, U.S. Pub. No. 2004/0170430 (published Sept. 2, 2004); Larsson, OFDM Signal Spectrum Shaping, U.S. Pub. No. 2009/0168844 (continuation of application filed Oct. 6, 2004, published July 2, 2009).
- The parties' Joint Claim Construction and Prehearing Statement, Joint Claim Construction Chart, and Joint Claim Construction Worksheet (filed January 14, 2016).
- Response of EICES Research, Inc. to: Air Force Topic AF131-049 of SBIR Program Solicitation FY 13.1, ODY0003053-72.
- EICES Research, Inc., Robust Communications for Low Probability of

Intercept (LPI), Low Probability of Detection (LPD) and Low Probability of Exploitation (LPE) of Communications Information, Proposal No. D052-019-0085, ODY0003640-54.

IV. LEGAL PRINCIPLES

17. I am not a legal expert and do not expect to provide any testimony about the law. Nevertheless, I have been provided the following legal standards as background for my work and to assist in forming my opinions regarding claim construction.

18. I have been informed that claim construction is a question of law for the Court to decide. The purpose of claim construction is to determine the meaning and scope of the claims asserted to be infringed, analyzed with an understanding of what the inventors actually invented.

19. A disputed claim term is read not only in the context of the particular claim in which the term appears but also in the context of the entire patent, including the specification. The specification has been referred to as "the single best guide to the meaning of a disputed term." For terms without a customary meaning within the art, the specification usually supplies the best context for deciphering claim meaning.

20. The prosecution history can also inform the meaning of the claim language by demonstrating how the inventor understood the invention and whether the inventor limited the invention in the course of prosecution, making the claim scope narrower than it otherwise would be. The Court may also consult extrinsic evidence, such as this declaration, in construing the claim terms.

21. Claim terms can operate as a substitute for "means" in the context of means-plus-function limitations where they provide only a generic description for software or hardware that performs a specific function. In addition, the recitation of a general purpose computer or microprocessor is not a sufficiently definite structure

for performing a specific function recited in the claims. For means-plus-function elements, the function is construed as described above and the claim is further limited to the structure disclosed in the specification as corresponding to the recited function. If the specification does not disclose any corresponding structure, the claim is invalid.

V. TUTORIAL

A. Using Bits and Symbols To Represent Digital Information

22. Digital communications involve the delivery of digital information. The basic principles have been known for quite some time, with a rich foundation based on both theory and practice. Digital information is often referred to as "bits" (***bi**nary digi**ts***). Each bit consists of either a logical "0" or a logical "1." Digital information can be represented by a stream of bits, such as 01101011.

23. Bits are often organized into groups known as "symbols," with each symbol representing a particular sequence of bits. The table below shows an example in which each symbol corresponds to a 2-bit sequence. To cover all possible 2-bit sequences, a set of 4 symbols is needed.

Bit Sequence	Symbol
00	A
01	B
10	C
11	D

24. More formally, to cover all possible combinations of k bits, the set needs $M = 2^k$ symbols. In the example above, because $k = 2$ bits, the signal set needs $M = 2^2 = 4$ symbols. The phrase "M-ary" is often used to refer to the number, "M," of symbols required.

25. Each signal in the set may be referred to as an element of an alphabet, much as the 26 individual letters of the English alphabet are elements of that alphabet. Considering the k = 2 example from above, that alphabet contains M = 4 elements.

26. Using symbols can allow for more efficient communications. Rather than transmitting one bit at a time, the transmitter can send a series of symbols that is converted into the stream of bits at the receiving end. For example, the stream of 8 bits noted above (01101011) could be transmitted using only 4 symbols (BCCD).

27. Grouping longer bit sequences into each symbol (i.e., using a higher k value) allows even more information per symbol but requires exponentially larger symbol sets. For example, a k of 3 bits requires 8 symbols (2^3), a k of 4 bits requires 16 symbols (2^4), and a k of 8 bits requires 256 symbols (2^8).

B. Sending Digital Information: Modulation

28. Digital information may be sent from a transmitter to a receiver over a wire or optical fiber, or wirelessly by radio waves. The portion of the medium used to transmit the information is often referred to as the "channel" (also sometimes referred to as the "physical channel").

29. To send information over a channel, the transmitter imparts the digital information onto a time-varying electrical signal. Physically, an electrical signal can take a variety of forms, such as a time-varying radio wave sent over the air or a time-varying voltage sent over a wire. The conversion from digital information into an electrical signal is performed by a component called a "modulator." The modulator imparts the digital information onto the wave by modulating, or varying, one or more characteristics of the wave. In the art, it is said that the modulator converts the bit stream into a continuous waveform.

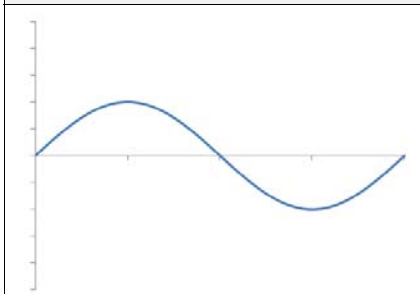
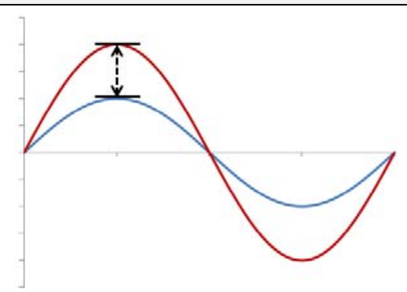
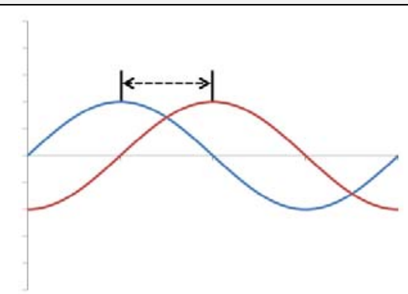
30. A modulated electrical signal is a physical entity but can also be represented mathematically. Mathematically, the modulated signal can be

represented by the symbolism *S(t)*, where *S* refers to an information-bearing signal and *S(t)* means that the signal waveform varies or changes over time *t*.

31. The job of the modulator is to create a different modulated signal for each different binary stream. Then, after the modulated signal is sent over the channel, the demodulator at the receiver inspects the arriving signal and tries to determine the signal that was actually sent from the transmitter.

1. Symbol-by-Symbol Signaling

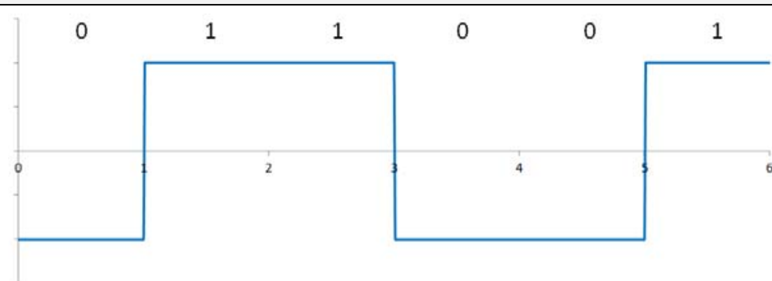
32. The figures below show sinusoidal waveforms. The Sinusoidal Waveform cell below shows a single sinusoidal waveform. The next cell shows two waveforms that have different amplitudes, with the red waveform being double the height of the blue waveform. The final cell shows waveforms with different phases, specifically a one-quarter-cycle difference in phase between the blue and red waveforms.

Sinusoidal Waveform	**Waveforms with Different Amplitudes**	**Waveforms with Different Phases**
		

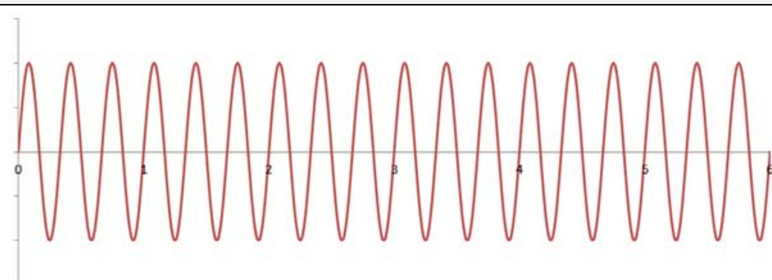
33. Digital information is often modulated onto a sinusoidal waveform known as the carrier. Information can be modulated onto a carrier by changing the amplitude of the carrier, the phase of the carrier, or both. A type of modulation known as "Quadrature Amplitude Modulation" or "QAM" changes both the amplitude and phase. Other types of modulation change only the phase or only the amplitude of the radio sine wave.

34. The figures below show an example of binary amplitude modulation. The bits are represented by an information signal that changes over time between two levels. For each of the six time periods in this example, a high signal indicates that the bit is a 1 and a low signal indicates that the bit is a 0. The carrier signal is a sinusoidal waveform with 3 cycles per period. Finally, the amplitude-modulated signal is created by modulating the information signal onto the carrier signal. The amplitude-modulated signal has a higher amplitude for the time periods when a 1 is being sent and a lower amplitude for the time periods when a 0 is being sent.

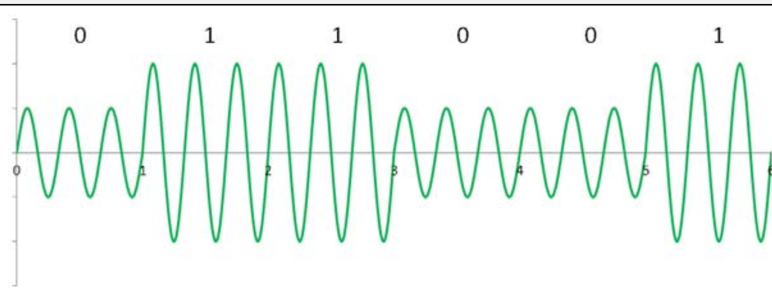
Information Signal



Carrier Signal



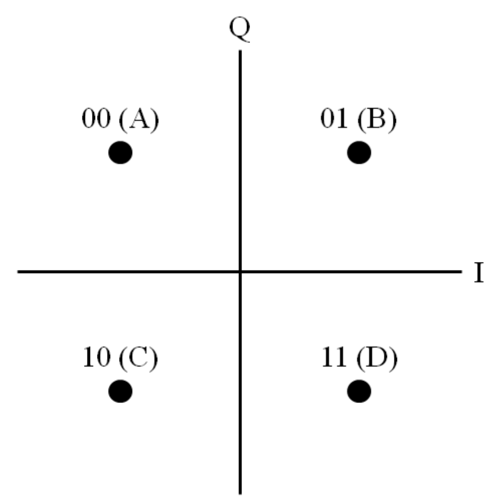
Amplitude-Modulated Signal



35. For modulation that changes both the amplitude and phase, the set of

possible amplitude and phase combinations form a "constellation." For example, the diagram below shows an amplitude and phase constellation based on two possible amplitudes and two possible phases, which yields four potential amplitude/phase combinations. Those 4 combinations correspond to 4 bit sequences (00, 01, 10, and 11) and 4 symbols (A through D). The axes refer to "I" and "Q" due to the mathematics used to represent the amplitude and phase-modulated signals.

4-QAM Constellation



36. To use this type of modulation – known as "symbol-by-symbol signaling" – the transmitter first forms a symbol from a set of k bits, and then uses the symbol to select one of M amplitude/phase combinations of the radio carrier. That is, each block of k bits is mapped to one amplitude/phase combination. This procedure is repeated periodically as each new group of k bits arrives for the transmission. (The time period for each symbol is given by T = k/R, where "T" is the time, "k" is the number of bits per symbol, and "R" is the number of bits per second.)

37. The receiver performs the opposite of the transmission steps to recover

the received constellation values. The receiver makes its best guess as to which constellation values were sent to determine which bit sequences were transmitted. For example, if QAM followed by simple carrier modulation is used, the receiver recovers the underlying bit stream by estimating the underlying amplitude and phase during each period.

38. Symbol-by-symbol modulation is, by far, the most common type of modulation encountered in practice. But it is not the only type of modulation. The next section describes an alternative type of modulation with particular relevance to the asserted patents.

2. Block Orthogonal Signaling

39. Another type of signaling scheme is sometimes referred to as "block orthogonal signaling." Block orthogonal signaling does not modulate a carrier using a constellation. Instead, block orthogonal signaling assigns each block of bits a different signal. When block orthogonal signaling is used, arriving bits are again grouped into symbols, each of which is an index to a different signal. Again, suppose that each arriving block contains k bits and, as before, there are $M = 2^k$ possible symbols. Each of these symbols then causes a different signal from a set of M independent signals to be sent. That is, block orthogonal signaling uses M different and independent signals, which are each known in advance and each associated with one of M possible symbols.

40. In addition, block orthogonal signaling uses a signal set consisting of "orthogonal" signals. At a high level, orthogonality refers to the elements of a set of signals being so different from one another that they can easily be distinguished. (This high-level description of orthogonality can be made mathematically precise, but that mathematical description is beyond the scope of this tutorial.) By allowing waveforms to be more readily distinguished from one another, orthogonal waveforms facilitate the recovery of bits at the receiver. Block orthogonal

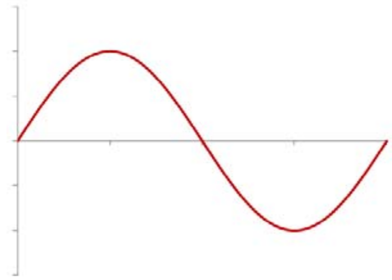
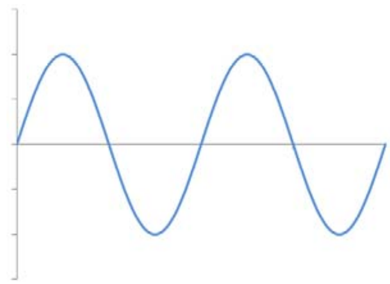
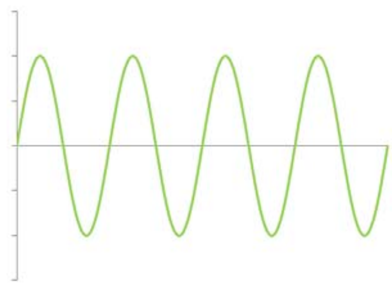
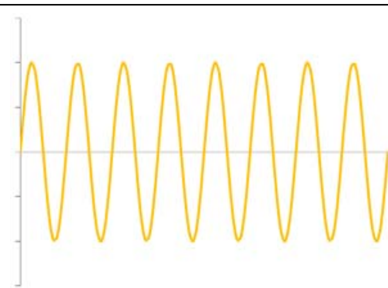
signaling uses such a known set of M orthogonal waveforms, each identified by one of $M = 2^k$ indices defined by a group of k bits.

41. A set of orthogonal signals are said to be "orthonormal" if they each use the same amount of energy. If each signal uses the same amount of energy, each signal will be just as likely to be successfully transmitted, absent other types of interference.

a. Frequency Shift Keying

42. One well-known type of block orthogonal signaling is known as "Frequency Shift Keying" or "FSK." In FSK, each symbol corresponds to a sinusoid with a unique radio frequency.

43. The chart below provides an example of a different sinusoid being used for each element of an $M = 4$ symbol set.

Bit Sequence	Symbol	FSK Signal
00	A	
01	B	
10	C	
11	D	

b. Pseudo-Random, Non-Cyclostationary Signal Sets

44. Another type of well-known block orthogonal signaling uses "non-cyclostationary" signals.

45. "Cyclostationarity" refers to the cyclic, or periodic, properties in many communications signals. The specific properties of a signal that are computed to determine their cyclostationarity (e.g., mean and autocorrelation functions) are

beyond the scope of this tutorial, but at a high level, can be used to determine whether a signal has periodic properties.

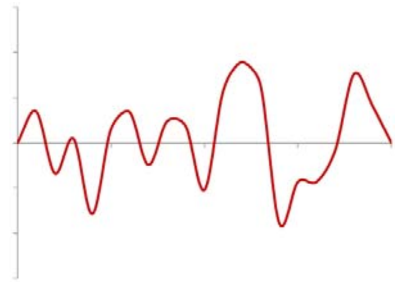
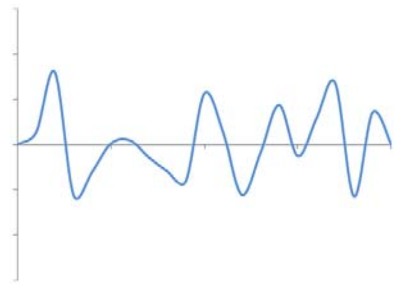
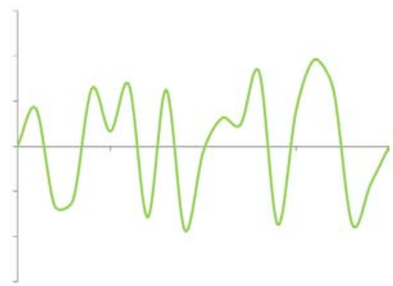
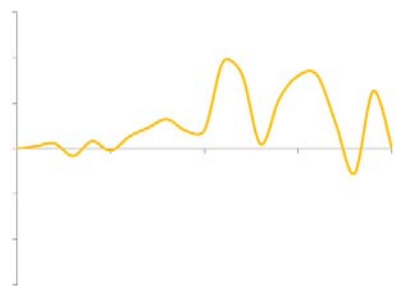
46. Commercial telecommunications applications often produce a highly periodic output, that is, a cyclostationary output. When symbol-by-symbol signaling is used, for example, the *same* underlying waveform is sent each period. For example, with QAM, the same radio sine wave is sent each period, varying only the amplitude and phase. QAM signals can be processed in such a way that the underlying periodic feature is extracted.

47. In contrast, signals with few (if any) cyclostationary properties are referred to as "non-cyclostationary," "featureless," or "pseudo-non-cyclostationary" signals. Naturally occurring background noise is one example of a non-cyclostationary signal.

48. One known way to produce an alphabet of non-cyclostationary signals is to use signals generated by a pseudo-random process. Pseudo-random signals are generated in such a way that the signals appear to be random but are produced by a repeatable process. By using the same process, both the transmitter and receiver can generate the same set of signals for the alphabet. (Or, even more directly, both the transmitter and receiver can be supplied with copies of the signals.)

49. Once the set of pseudo-random signals has been created, they can be used in a conventional block orthogonal signaling fashion. The bits are segmented into blocks of k bits each, and one of M symbols is formed for each block. Each symbol corresponds to a unique one of M non-cyclostationary signals. A sequence of such signals is sent, with each individual signal corresponding to one of the sequence of k-bit blocks.

50. The chart below depicts an example of a set of M = 4 pseudo-random signals in a hypothetical alphabet:

Bit Sequence	Symbol	Pseudo-Random Signal
00	A	
01	B	
10	C	
11	D	

51. The distinction between cyclostationary and non-cyclostationary signals can be used in determining whether a signal is man-made. For example, some applications (such as covert military applications) use non-cyclostationary signals to avoid eavesdroppers from being able to determine that a man-made signal is being sent. In contrast, although commercial systems use cyclostationary signals that can be detected as man-made, they apply encryption to ensure that only

authorized receivers can decode a signal.

C. Addressing Channel Impairments

1. Transmission Channels May Suffer from Interference and Other Impairments

52. In the real-world, the channel between a transmitter and receiver includes many sources of interference and distortion. For example, additive interference refers to nearby transmitters sending radio signals that partially or totally overlap with the signal of interest. Additive background electromagnetic noise may also interfere with the signal. Another example of a channel impairment is multipath propagation. Like a hiker who shouts into a canyon can hear several echoes, a receiver can receive multiple copies of the same signal that have arrived via different paths (e.g., via reflections off of buildings, walls, and trucks). The receiver's own electronic equipment may even introduce distortion.

53. Channel impairments cause detection of bits at the receiver to be imperfect: some bits will be detected in error, that is, the receiver may estimate a "1" as a "0" or vice-versa. A common measure of the quality of the link between the transmitter and the receiver is related to the fraction of bits that are detected in error, that is, the Bit-Error-Rate ("BER"). For the BER, 0% is perfection and 50% means that half of the bits are detected incorrectly by the receiver.

2. Channel Impairments May Be Analyzed in the Frequency Domain

54. The "spectrum" of available frequencies may be divided into channels of different frequency ranges. One common example is that national regulatory authorities, such as the Federal Communications Commission ("FCC"), divide the available wireless spectrum into different frequency ranges, providing certain ranges to certain types of applications. These regulatory channels may be further divided into channels of varying frequency ranges.

55. In channelized media, some channels typically have better quality than

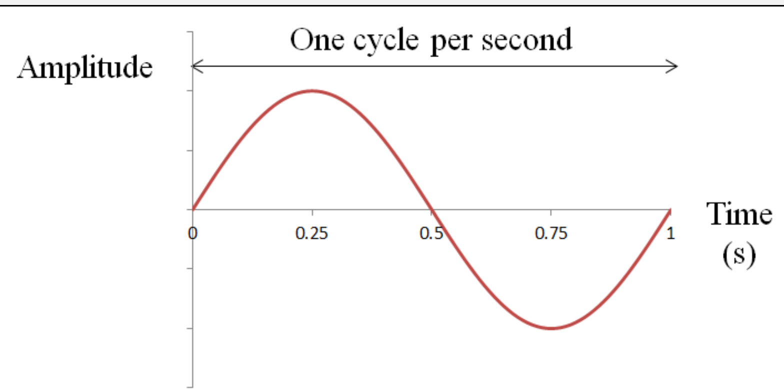
other channels. For example, the level of interference might be different among the channels. Channels with higher interference would have degraded performance. As another example, the level of attenuation might be different for the different channels, with higher attenuation also degrading performance. In general, all other conditions being equal, the more degraded the channel, the lower the rate at which information may be sent with an acceptable BER.

56. The amount of interference may be estimated for each channel. For example, a device may take samples of background signals over time and then compute the power levels of the background signals at various frequencies.

57. To explain this point further, more context regarding "time domain" and "frequency domain" representations of signals may be useful.

58. As depicted below, a "time domain" representation of a signal, also known as a "waveform," shows how the amplitude of the signal changes over time using an amplitude axis and a time axis. The picture below shows a signal that has a frequency of one cycle per second, also known as 1 Hz (Hertz). Most wireless signals operate at frequencies in the millions or billions of Hz.

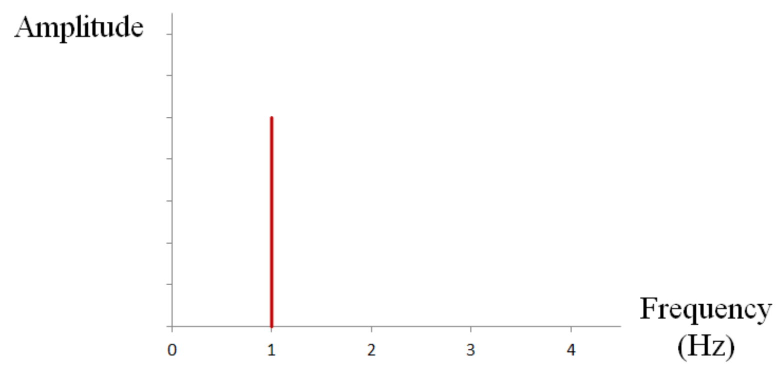
Time-Domain Representation



59. A "frequency domain" representation of a signal includes an amplitude axis but uses a frequency axis rather than a time axis. A frequency-domain

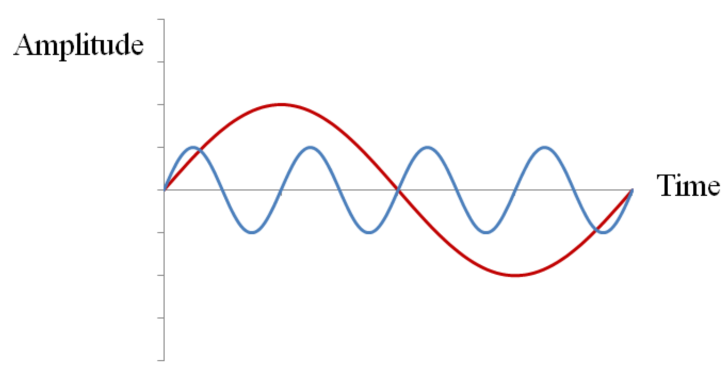
representation of the 1 Hz signal above includes a single line at 1 Hz.

Frequency-Domain Representation

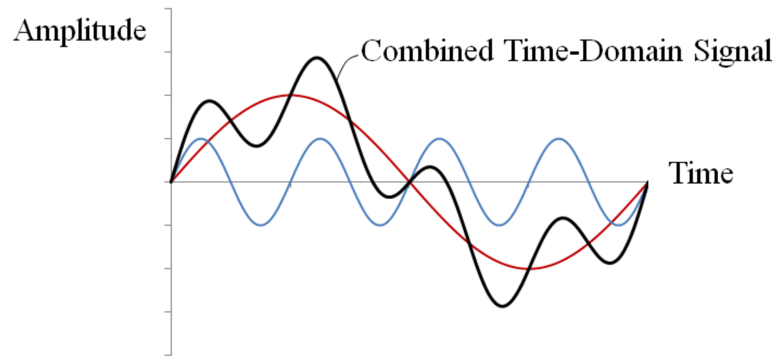


60. As depicted below, a waveform may be comprised of multiple signals. For example, the time-domain figure below shows a 1 Hz signal in red and a signal in blue with a higher frequency (4 Hz) and a lower amplitude. The next figure shows a waveform that is the combination of the two time-domain signals together. Finally, the figure at the bottom shows the frequency-domain representation of the combined signal.

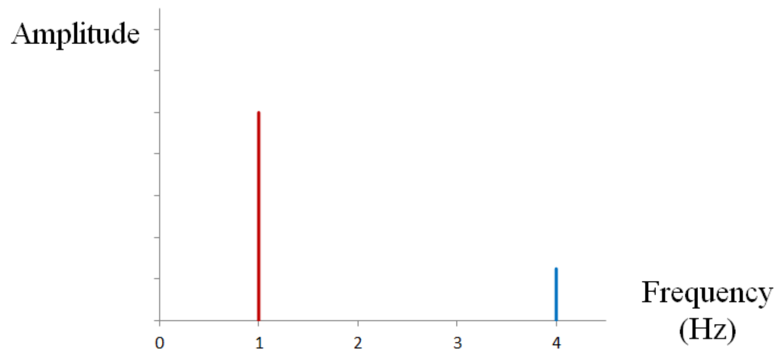
Time-Domain Representation of Two Signals



Time-Domain Representation of Combined Signal



Frequency-Domain Representation of Combined Signal



61. Mathematical operations known as Fourier transforms can be used to convert between time-domain and frequency-domain representations of a waveform or signal. Forms of Fourier transforms known as Fast Fourier Transforms and Inverse Fast Fourier Transforms have been popular for approximately fifty years. Fourier Transforms can be used to convert a time-domain signal into the frequency domain, and Inverse Fourier Transforms can be used to convert a frequency-domain signal into the time domain. Fourier transforms also have many other applications.

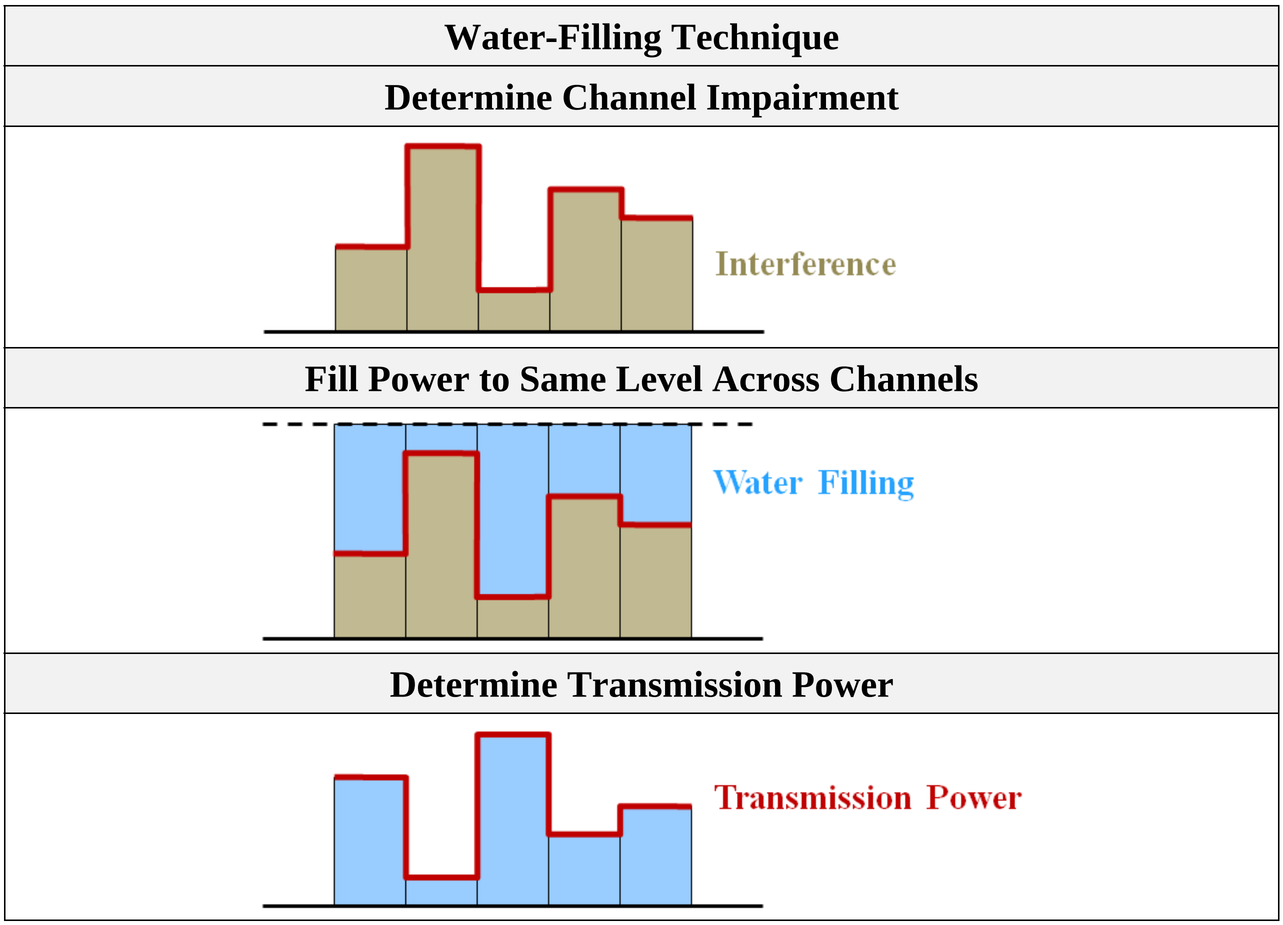
3. "Water Filling" Can Optimize the Use of Impaired Channels

62. With that background, one can consider how to efficiently allocate power among channels that are subject to different impairments, such as interference.

63. This is a well-known problem, with solutions that the industry

developed decades ago. Essentially, if the transmitter has a limited amount of power, then the transmitter should allocate more power to channels with less interference and less power to channels with more interference.

64. The solution is often called "water filling," which is depicted and described below.



65. The first diagram above shows the estimation of the channel impairments. The various heights (shown in brown) represent the degree of channel impairment and are viewed as the bottom of a bucket. (The figure shows five channels.) If interference is the problem, the bottom of the bucket will be higher for those channels where the interference is high, with the height of the bottom equal to the amount of interference present. The red line indicates the shape

of the bottom of the bucket.

66. The second diagram shows the "water" (in blue) poured into the bucket, with the resulting water level shown as a dotted line. The water represents the amount of power used for transmission on each channel. When the water is poured, more water will be present for channels where the bottom of the vessel is low, and less (or no) water will be present for channels where the bottom is high. The water level may result, for example, from the maximum electrical power level that can be drawn from a power supply, the maximum level of power that can be radiated as permitted by a regulatory body, the maximum level of power that avoids interfering with other transmitters, or the maximum level of power to maintain a covert level of transmission.

67. The third diagram shows the resulting amount of transmission power to be allocated for each channel.

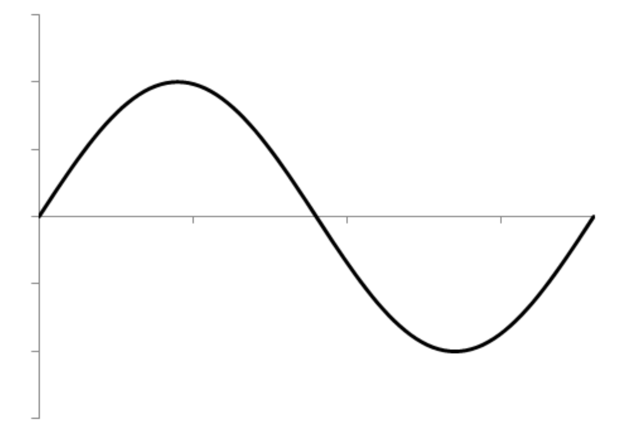
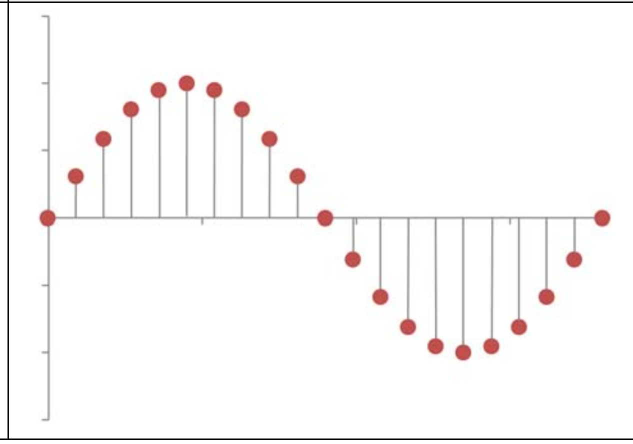
4. Sampling and Discrete-Time Waveforms

68. A final concept for this tutorial relates to "sampling."

69. The waveforms shown above have been "continuous-time" waveforms. Continuous-time waveforms refer to waveforms that do not have any breaks or interruptions.

70. Rather than measuring the value of a signal continuously, a device may take samples of a waveform at specific times. A waveform consisting of a sequence of samples can be referred to as a "discrete-time waveform."

71. The diagram below shows a continuous-time waveform in black, and a discrete-time waveform using red circles.

Continuous-Time Waveform	**Discrete-Time Waveform**
	

72. A discrete-time waveform can be represented graphically as above or by a series of numbers. If the device takes "N" samples, then the discrete-time waveform will include N numbers. For example, the discrete-time waveform shown above has N = 20 samples, with the N amplitude values being {0.0, 0.3, 0.6, 0.8, 0.9, 1.0, 0.9, 0.8, 0.6, 0.3, 0.0, -0.3, -0.6, -0.8, -0.9, -1.0, -0.9, -0.8, -0.6, -0.3}.

73. Discrete-time waveforms have long been used, in part because they allow for faster and more economical digital processing techniques.

VI. OVERVIEW OF THE PATENTS-IN-SUIT

74. The patents-in-suit are directed to a digital telecommunications system (transmitter and receiver) for use in a covert setting. For example, the '393 patent states:

> *This invention relates to low interference, high privacy, featureless covert communications systems* and/or methods that may also comprise cognitive capability. More specifically, the invention relates to wireless communications systems and/or methods (that may comprise wireless spread-spectrum communications systems and/or methods), that can provide low interference, high privacy, high covertness, featureless and/or cognitive capability. *The invention also relates to Low Probability of Intercept (LPI), Low Probability of*

> *Detection (LPD), Low Probability of Exploitation (LPE) and/or Minimum Interference Communications (MIC) systems*, methods, devices and/or computer program products that may also be used to provide low interference, white space spectrum communications commercially.

('393 col. 1:40-54 (Field of the Invention) (emphasis added).)

75. The patents-in-suit assert that "[c]onventional communication systems" – such as GSM and CDMA-based systems like CDMA2000 or WCDMA – are undesirable for covert communications, because they use "waveforms that are substantially cyclostationary":

> *Conventional communications systems use waveforms that are substantially cyclostationary.* This is primarily due to a methodology of transmitting information wherein a unit of information (i.e., a specific bit sequence comprising one or more bits) is mapped into (i.e., is associated with) a specific waveform shape (i.e., a pulse) and the pulse is transmitted by a transmitter in order to convey to a receiver the unit of information. Since there is typically a need to transmit a plurality of units of information in succession, a corresponding plurality of pulses are transmitted in succession. Any two pulses of the plurality of pulses may differ therebetween in sign, phase and/or magnitude, but a waveform shape that is associated with any one pulse of the plurality of pulses remains substantially invariant from pulse to pulse and a rate of pulse transmission also remains substantially invariant (at least over a time interval). The methodology of transmitting (digital) information as described above has its origins in, and is motivated by, the way Morse code evolved and was used to transmit information. Furthermore, the methodology yields relatively simple transmitter/receiver implementations and has thus been adopted widely by many communications systems. *However, the methodology suffers from generating cyclostationary features/signatures that are undesirable if LPE/LPI/LPD and/or minimum interference*

> *communications are desirable.*

('393 col. 19:1-25 (emphasis added).)

> Examples of a repeating signature/pattern are a bit rate, a symbol rate, a chipping rate and/or a pulse shape (e.g., a Nyquist pulse shape) that may be associated with a bit/symbol/chip. *For example, each of the well known terrestrial cellular air interfaces of GSM and CDMA (cdma2000 or W-CDMA) comprises a bit rate, a symbol rate, a chipping rate and/or a predetermined and invariant pulse shape that is associated with the bit/symbol/chip and, therefore, comprise a cyclostationary property/signature.*

('393 col. 18:50-59 (emphasis added).)

76. According to the patents-in-suit, a "sophisticated interceptor" could use a "cyclic periodogram" to detect the presence of cyclostationary communications:

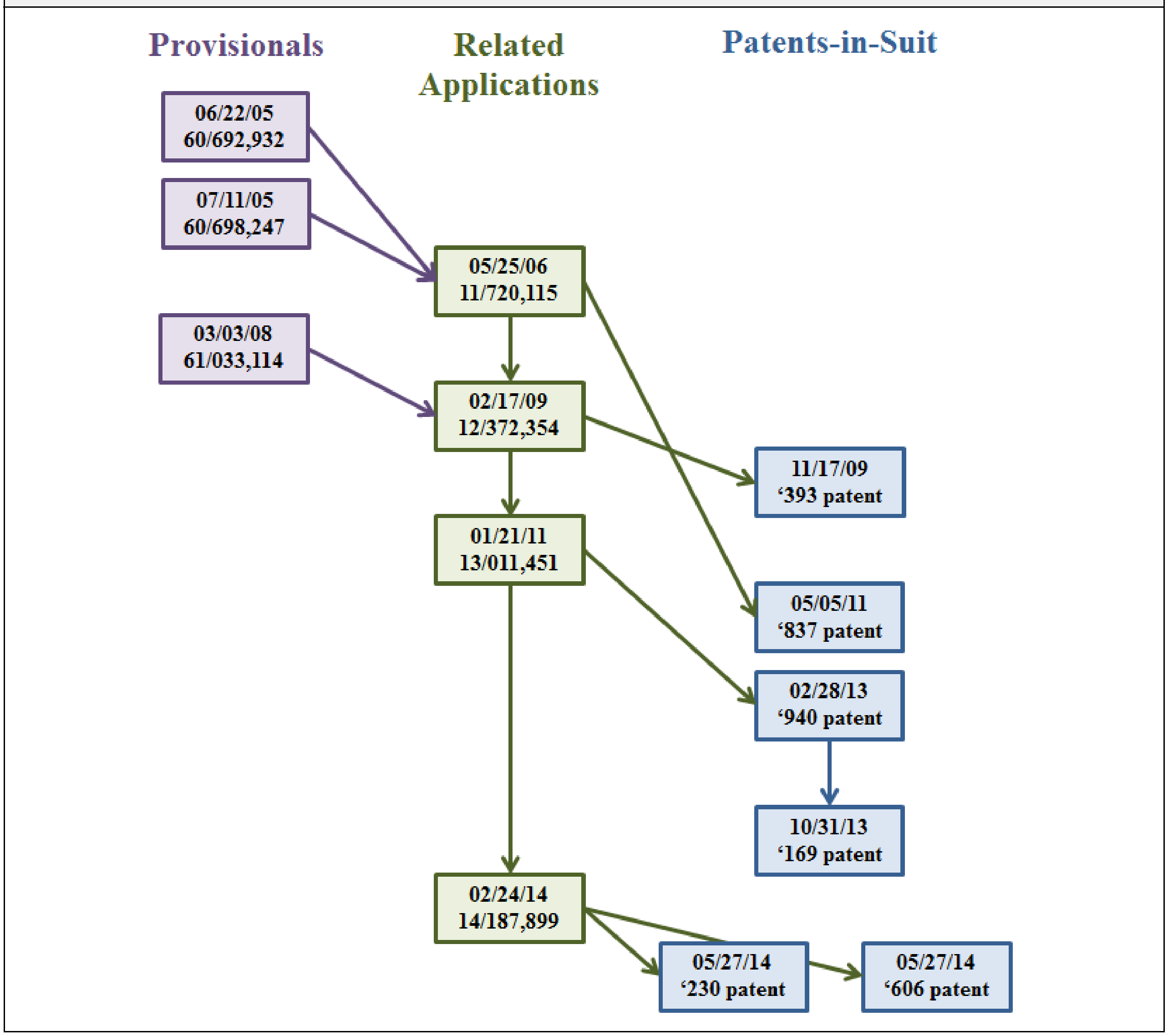
> *A cyclic signal feature associated with a signal's cyclostationary property, may be identified via a "cyclic periodogram."* The cyclic periodogram of a signal is a quantity that may be evaluated from time-domain samples of the signal, a frequency-domain mapping such as, for example, a Fast Fourier Transform (FFT), and/or discrete autocorrelation operations. Since very large point FFTs and/or autocorrelation operations may be implemented using Very Large Scale Integration (VLSI) technologies, Digital Signal Processors (DSPs) and/or other modern technologies, a receiver of an interceptor may be configured to perform signal Detection, Identification, Interception and/or Exploitation (D/I/I/E) based on cyclic feature detection processing.
>
> Given ... the potential advantage(s) of cyclic feature detection technique(s) *it is reasonable to expect that a sophisticated interceptor may be equipped with a receiver based on cyclic feature detection processing.*

('393 col. 19:64-20:15 (emphasis added).)

77. As discussed in detail below, the patents-in-suit seek to avoid cyclic feature detection by using a signaling alphabet made up of pseudo-random, non-cyclostationary waveforms. Some of the patents-in-suit also shape the spectrum of the signaling alphabet in an attempt to avoid interfering with other transmitters.

78. The figure below shows the relationship between the patents-in-suit and related applications. I discuss the patents, related applications, and prosecution histories in more detail below as they relate to particular disputed claim constructions.

Applications Related to the Patents-in-Suit



79. In addition, the patents-in-suit and related applications share many of the same disclosures, as noted in the chart below:

Patents/Apps	Figs. 1-6	Figs. 7-15	Fig. 16	Long Summary	Figs. 17-25	Figs. 26-27
06/22/05 60/692,932 N/A	Included					
07/11/05 60/698,247 N/A	Included	Included				
05/26/06 11/720,115 8,050,337	Included	Included	Included	Included		
03/03/08 61/033,114 N/A	Included	Included	Included	Included	Included	
02/17/09 12/372,354 7,876,845	Included	Included	Included	Included	Included	
11/17/09 '393 patent	Included	Included	Included	Included	Included	
01/21/11 13/011,451 8,670,493	Included	Included	Included	Included	Included	Included
05/05/11 '837 patent	Included	Included	Included	Included		
02/28/13 '940 patent	Included	Included				
10/31/13 '169 patent	Included	Included				
02/24/14 14/187,899 8,811,502	Included	Included	Included	Included	Included	Included
05/27/14 '230 patent	Included	Included	Included	Included	Included	
05/27/14 '606 patent	Included	Included	Included	Included	Included	

VII. OPINIONS REGARDING DISPUTED CLAIM TERMS

A. "U(nT)" (Term 14) – All Patents-in-Suit

80. I understand that the chart below indicates the parties' competing proposed constructions for this term:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"U(nT)" (Term 14)	"a waveform within a set of discrete-time, pseudo-random non-cyclostationary and orthogonal and/or orthonormal waveforms that define a waveform alphabet"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "a discrete time-domain waveform, wherein n denotes a discrete time index of the discrete time-domain waveform"

81. I understand that Odyssey[1] contends that the term "U(nT)" has a customary meaning in this field independent from the patents-in-suit. I disagree.

82. The term "U(nT)" does not have any ordinary or customary meaning in this field but is instead a term coined and defined in the patents-in-suit. For example, if Odyssey had used the term "U(nT)" in a scientific paper, the reader would need to look to the rest of the paper to understand the meaning of that term in the context of the paper. Similarly, a person of skill would need to look at the patents to understand what the claims mean by "U(nT)."

83. I also understand that Odyssey contends, in the alternative, that "U(nT)" covers any "discrete time-domain waveform, wherein n denotes a discrete time index of the discrete time-domain waveform." I disagree with this contention

[1] In this declaration, I use "Odyssey" to refer to Odyssey as well as its predecessor company EICES and the named inventor.

as well, as it conflicts with the claim language, the written description, and the prosecution histories.

84. Starting with the claim language, the claims already include the characteristics listed by Odyssey's alternative construction. For example, claim 1 of the '393 patent recites:

> generating a discrete time-domain waveform U(nT); wherein n denotes a discrete time index of U(nT), wherein n=1, 2, ... , N ....

('393 claim 1.) Thus, Odyssey's proposed alternative construction simply repeats language that is already elsewhere in the claims.

85. As discussed above, the patents-in-suit are directed to covert communication systems. To avoid detection by a "cyclic periodogram," the patents-in-suit describe and claim a specific "signaling alphabet" made up of "waveforms substantially devoid of a cyclostationary signature":

> A wireless communications system configured for Low Probability of Intercept (LPI), Low Probability of Detection (LPD) and/or Low Probability of Exploitation (LPE) communications may use *waveforms substantially devoid of a cyclostationary signature* to improve a LPI/LPD/LPE property. A set of M independent "seed" waveforms that satisfy a time-bandwidth constraint may be used via a Gram-Schmidt Orthogonalization (GSO) procedure to generate M orthonormal functions. In accordance with exemplary embodiments of the present invention, the M seed waveforms may, for example, be chosen from a band-limited Gaussian-distributed process (such as, for example, Gaussian-distributed pseudo-random noise) and may be used to generate, via an orthogonalization operation, such as, for example, a GSO, a corresponding set of M Gaussian-distributed orthonormal functions substantially devoid of a cyclostationary property.
>
> *The set of M Gaussian-distributed orthonormal functions may be used in a communications system to define a*

> *signaling alphabet of a transmitter of the communications system* (and a corresponding matched filter bank of a receiver of the communications system) to thereby reduce or eliminate a cyclostationary signature of a transmitted communications waveform and thus increase a covertness measure and/or a privacy measure of the communications system.
>
> The set of M Gaussian-distributed orthonormal functions may be updated, modified and/or changed as often as necessary to further increase and/or maximize a covertness/privacy measure of the communications system.

('393 col. 2:16-43 (Summary of the Invention) (emphasis added); '393 col. 19:55-20:15.)

86. The patents-in-suit use the term "U(nT)" to refer to a waveform with the specific characteristics described by the patents for making communications covert. The U(nT) waveforms make up the signaling alphabet.

87. Figure 1 is central to the alleged invention in the patents-in-suit. Everything described later in the patents relies on the disclosure and definitions in Figure 1. Figure 1 defines the nomenclature used in the patents, which do not deviate or backtrack from the nomenclature.

88. Figure 1 describes the creation of the signaling alphabet and is common to all the patents-in-suit. At a high level, Figure 1 shows a block diagram of a transmitter that "generat[es] a communications alphabet comprising M distinct pseudo-random, non-cyclostationary, orthogonal and/or orthonormal waveforms," defining the term "U(nT)" as a waveform in that alphabet. ('393 col. 20:21-23; '393 col. 20:21-21:52.)

‘393 Fig. 1 (annotated)

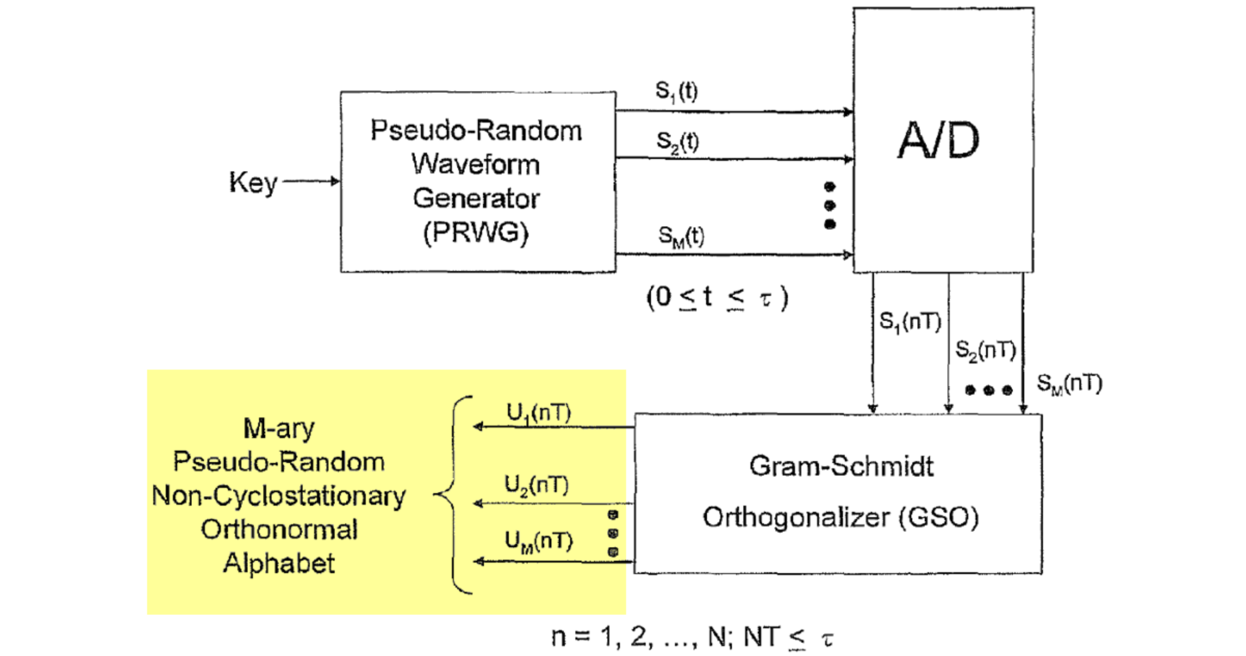


FIGURE 1

89. In more detail, starting at the upper left in Figure 1, the Pseudo-Random Waveform Generator (PRWG) receives keys or time-of-day values as inputs and outputs a set of M distinct pseudo-random waveforms, labeled as “$S_1(t)$, $S_2(t)$, ... , $S_M(t)$.” (‘393 col. 20:24-34, 20:48-54.)

90. Figure 3 shows an example of a procedure for generating the M pseudo-random waveforms. First, a pseudo-random waveform $S_L(t)$ can be generated, with the waveform changing randomly over time. (‘393 col. 20:66-21:3.) By taking chunks of $S_L(t)$ – with each chunk of time duration τ – one can generate pseudo-random waveforms $S_1(t)$ and $S_2(t)$. Figure 3 shows the jagged, pseudo-random waveforms for $S_1(t)$ and $S_2(t)$ as examples. (‘393 Fig. 3.)

'393 Fig. 3

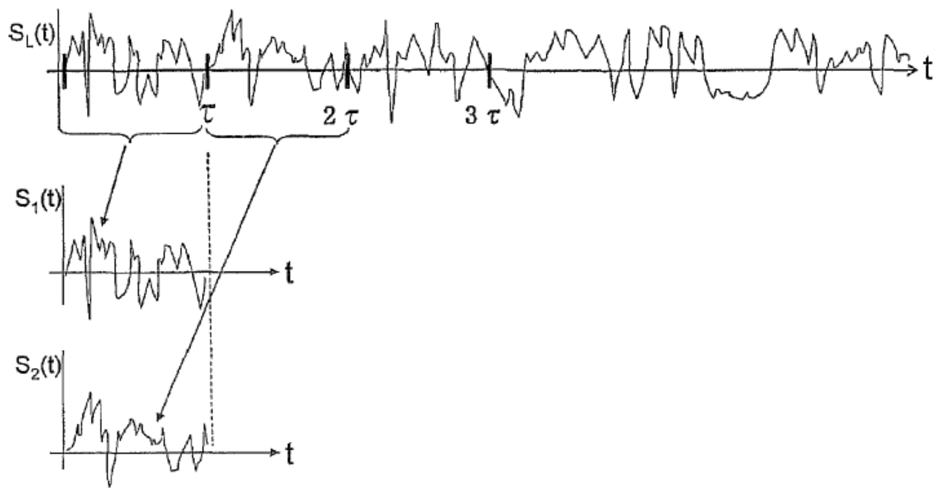


FIGURE 3

91. Returning to Figure 1, each of the M distinct pseudo-random waveforms is converted from a continuous-time, analog signal to a discrete-time, digital signal by an analog-to-digital (A/D) converter. ('393 col. 21:32-41.) The A/D converter receives the continuous-time, analog waveform signals, $S_1(t)$, $S_2(t)$, ... , $S_M(t)$, as input. (*Id.*) The A/D converter takes n samples for each waveform and outputs a discrete-time, digital signal consisting of a set of samples, including the values for each of the samples. (*Id.*)

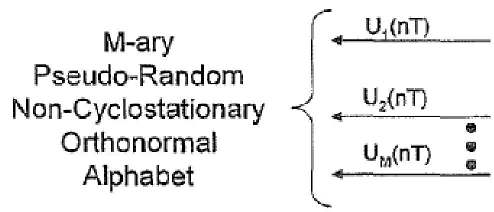
92. The patents-in-suit describe these sets of samples as "substantially discrete-time representation[s]" and label them as "$S_1(nT)$, $S_2(nT)$, ... , $S_M(nT)$." (*Id.*) Each of these sets includes n numbers. For example, $S_1(nT)$ is the set of n numbers $S_1(T)$, $S_1(2T)$, $S_1(3T)$, ... , $S_1(nT)$, which refer to the samples of $S_1(t)$ at times T, 2T, 3T, and so on.

93. Finally, Figure 1 shows an orthonormalization step. Specifically, the set of M sampled and digitized pseudo-random waveforms are converted into an orthonormal set of M sampled and digitized pseudo-random waveforms.

94. Figure 1 defines the output of the orthonormalization process as "$U_1(nT)$, $U_2(nT)$, ... , $U_M(nT)$." As noted above, each element contains n samples.

95. Figure 1 further defines the set of "$U_1(nT)$, $U_2(nT)$, ... , $U_M(nT)$" as an "M-ary Pseudo-Random Non-Cyclostationary Orthonormal Alphabet." The standard notation for indicating a set is "{}." Figure 1 uses that standard notation to show that the set of U(nT) elements is the alphabet.

'393 Fig. 1 (excerpt)



96. The text in the patents-in-suit describing Figure 1 also expressly equates the set of U(nT) elements with the set of waveforms "$U_1(nT)$, $U_2(nT)$, ... , $U_M(nT)$," again using the standard set notation:

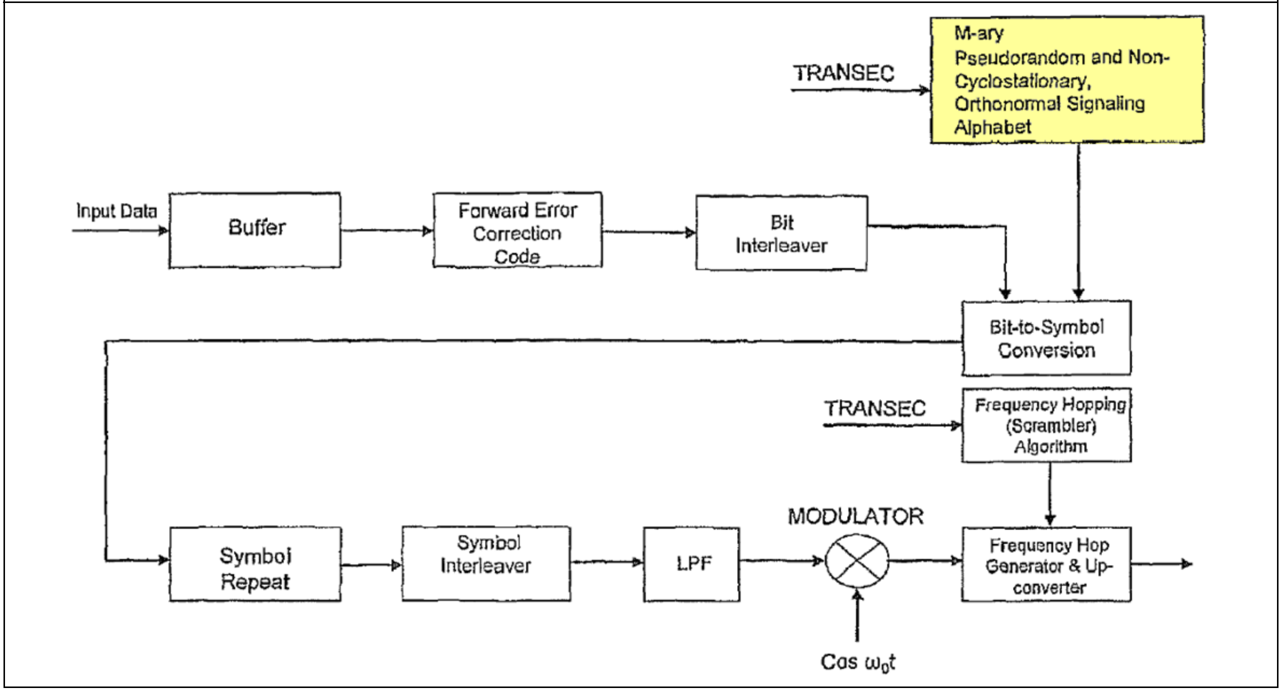
> A Gram-Schmidt orthogonalizer and/or orthonormalizer and/or any other orthogonalizer and/or orthonormalizer, may then be used as illustrated in FIG. 1 to generate a set of waveforms ***{U(nT)}={U₁(nT), U₂(nT), ... , U_M(nT)}***; n=1, 2, ... , N; NT≤τ that are orthogonal and/or orthonormal therebetween.

('393 col. 21:41-46.)

97. Thus, in Figure 1, the patents-in-suit expressly define the waveforms "U(nT)" as "Pseudo-Random," "Non-Cyclostationary," and "Orthonormal." ('393 Fig. 1.)

98. Figure 5 likewise defines the patents' signaling alphabet as an "M-ary Pseudorandom and Non-Cyclostationary Orthonormal Signaling Alphabet." ('393 Fig. 5.)

'393 Fig. 5 (annotated)



99. Three of the patents-in-suit (the '393, '230, and '606 patents) also include a disclosure relating to a water-filling method for creating the signaling alphabet. The patents refer to this method as the "neXt Generation (XG) Chipless Spread-Spectrum Communications (CSSC) System" or "XG-CSSC." ('393 col. 29:14-22.) Figures 17-25 and the associated text contain the XG-CSSC disclosure.

100. Like the figures discussed above, the XG-CSSC disclosure states that it uses waveforms "devoid of any cyclostationary signature" and thus "provides extreme privacy":

> INTRODUCTION & EXECUTIVE SUMMARY: According to some embodiments of a neXt Generation (XG) Chipless Spread-Spectrum Communications (CSSC) system, described further hereinbelow and referred to as "XG-CSSC," *XG-CSSC provides extreme privacy*, cognitive radio capability, robustness to fading and interference, communications performance associated with M-ary orthonormal signaling and high multiple-access capacity. *XG-CSSC uses spread-spectrum*

> *waveforms that are* devoid of chipping and *devoid of any cyclostationary signature*, statistically indistinguishable from thermal noise and able to cognitively fit within any available frequency space (narrow-band, broad-band, contiguous, non-contiguous).

('393 col. 29:14-27 (emphasis added).)

101. Figure 17 depicts the overall XG-CSSC transmitter. Like Figure 1, the Figure 17 transmitter creates a set of pseudo-random waveforms, using a "Uniformly Distributed Random Phase Generator" and "IFFT" to do so. ('393 Fig. 17.) Those random waveforms are labeled as "M independent Complex Gaussian Sequences" in Figure 17. Those pseudo-random waveforms are then passed through a Gram-Schmidt Orthonormalizer to output the "M-ary Orthonormal Alphabet." ('393 Fig. 17.)

102. The text describing Figure 17 equates the M-ary orthonormal alphabet with the set of waveform elements that make up the signaling alphabet: "The set of orthonormal waveforms $\{U_1(nT), U_2(nT), \ldots, U_M(nT)\}$ may be used to define an M-ary orthonormal Gaussian-distributed signaling alphabet ...." ('393 col. 30:45-50.)

103. "Gaussian" here refers to a specific type of statistical distribution. For example, the Summary of the '393 patent states:

> A set of M independent "seed" waveforms that satisfy a time-bandwidth constraint may be used via a Gram-Schmidt Orthogonalization (GSO) procedure to generate M orthonormal functions. In accordance with exemplary embodiments of the present invention, the M seed waveforms may, for example, be chosen from a band-limited *Gaussian-distributed process (such as, for example, Gaussian-distributed pseudo-random noise)* and may be used to generate, via an orthogonalization operation, such as, for example, a GSO, a corresponding set of M Gaussian-distributed orthonormal functions substantially devoid of a cyclostationary property.

('393 col. 2:21-31 (emphasis added).)

104. The Figure below is annotated to show the location of the S(nT) and U(nT) elements:

'393 Fig. 17 (annotated)

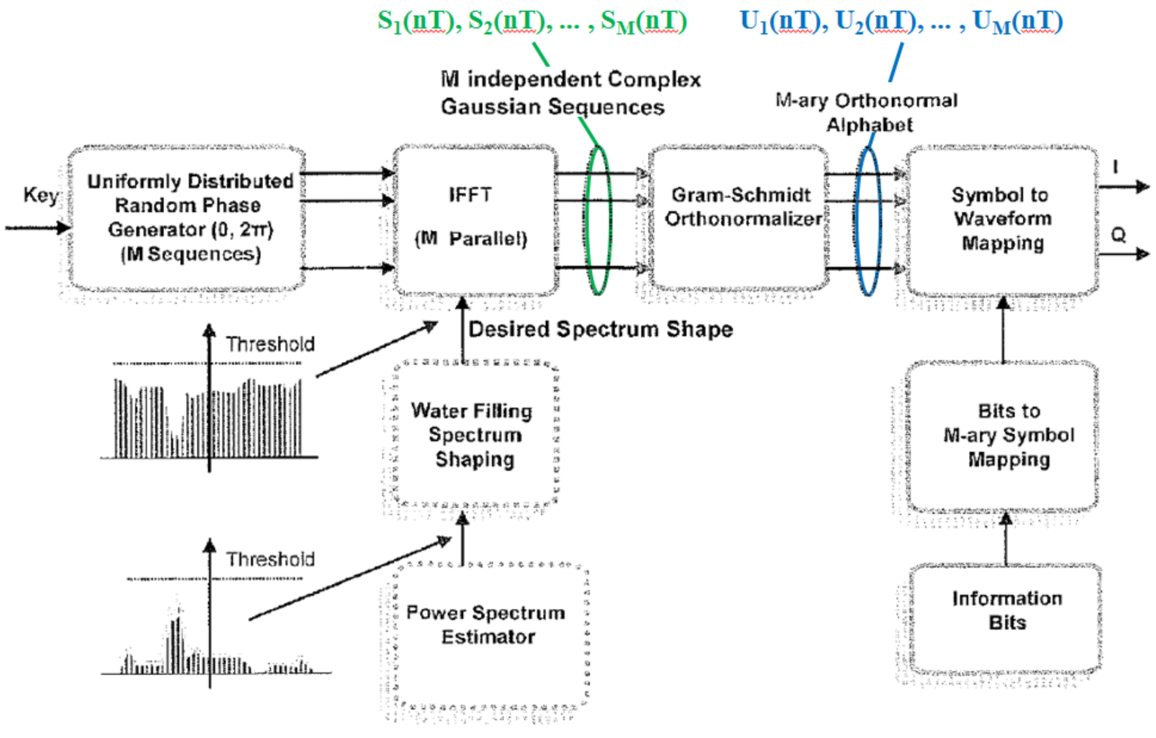


FIGURE 17

105. Thus, the XG-CSSC disclosure also uses U(nT) to refer to a waveform within a pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveform alphabet.

106. In the joint claim construction chart, Odyssey points to only Figure 16 and the accompanying text. But a person of skill would not read Figure 16 as broadening the meaning of "U(nT)" to include waveform elements that lack pseudo-random, non-cyclostationary, and orthonormal characteristics.

107. To the contrary, Figure 16 simply refers to a dual-mode device that is always capable of sending non-cyclostationary waveforms using the {U(nT)}

signaling alphabet and is optionally also able to send cyclostationary waveforms using techniques from the prior art, such as QAM constellations discussed above in the tutorial, depending on which type of signals the user wants to send. (‘393 Fig. 16, col. 28:6-21.) Figure 16 does not disclose a device that can send only conventional, cyclostationary signals. Accordingly, Odyssey’s citation to Figure 16 is irrelevant.

108. The prosecution histories of parents to the patents-in-suit also confirm that the waveforms that Odyssey allegedly invented include specific characteristics.

109. In May 2006, Odyssey filed a non-provisional application that included Figures 1-16 and the text corresponding to those figures. (U.S. Application Serial No. 11/720,115 (filed May 25, 2006).)

110. The ‘115 application included claims with differences from the claims at issue in this case. But Odyssey distinguished the patents’ alleged invention as a whole from the prior art in several ways during the U.S. prosecution.

111. First, Odyssey distinguished the patents’ signaling alphabet from “conventional” systems—including OFDM, CDMA, GSM, QPSK, QAM, and the English language—on the ground that the patents’ signaling alphabet uses pseudo-random waveform elements, whereas conventional systems use elements that are “deterministically predetermined,” “purely deterministic,” “invariant,” etc., such as the constellation points discussed above in the tutorial:

<u>Generally</u>

> *All communications systems described earlier, relating to the English language, QPSK, GSM and CDMA, use respective communications alphabets that are made-up entirely of deterministically predetermined point symbols, NOT waveforms.* That is, the alphabet that is used in communicating via the English language comprises 26 deterministically predetermined “point” entities, each representing a respective letter. The alphabet that is used by a QPSK system includes only four deterministically

> predetermined point entities, representing the bits "00," "01," "10" and "11," respectively. Similarly, the communications alphabets used by the GSM and CDMA systems use deterministically predetermined point sets. *In fact, conventional communications systems, whether human-language-based or electronically-based, use a communications alphabet that is a priori deterministically arrived at (and agreed upon) by convention. The concept of using a pseudo-randomly generated alphabet that comprises a plurality of waveform elements is simply foreign and goes against the grain of conventional communications systems....*

('115 Prosecution History, Request for Reconsideration at ODY_DEFS_00000311 (May 3, 2011) (emphasis added).)

> Gorokhov is silent on this point but those skilled in the art, including the Examiner, will appreciate that the communications alphabets cited by Gorokhov comprise *constellation points NOT waveform elements as is taught by the present Application ....*

('115 Prosecution History, Remarks at ODY_DEFS_00000505 (May 24, 2010) (emphasis added).)

<u>QPSK</u>

> The Examiner is correct that Paragraph [0030] of Gorokhov discloses that the communications alphabet may include QPSK. However, as was shown above, *the communications alphabet used in QPSK is purely deterministic ....*

('115 Prosecution History, Remarks at ONY_DEFS_00000404 (Oct. 12, 2010) (emphasis added).)

> *[T]here is nothing random about any element of the communications alphabet used in [QPSK] modulation. The communications alphabet of QPSK comprises four predetermined elements (constellation points).* Anyone who is familiar with QPSK would envision the same four alphabet elements (constellation points), namely: (1,1) in

> the first quadrant, (-1,1) in the second quadrant, (-1,-1) in the third quadrant, and (1,-1) in the fourth quadrant. There is nothing random or pseudo-random about the four alphabet elements of QPSK. Each one is predetermined, invariant and known to be as stated above.

('115 Prosecution History, Request for Reconsideration at ODY_DEFS_00000299-300 (May 3, 2011) (emphasis added).)

<u>GSM & CDMA</u>

> *As is the case for QPSK described above, a GSM system or a CDMA system uses a communications alphabet whose elements are predetermined constellation points, NOT pseudo-random waveform elements that have been generated responsive to any statistical distribution. The communications alphabet used by GSM (i.e., Gaussian Minimum Shift Keying, or "GMSK") includes only four deterministic/predetermined constellation points (not waveform elements)* that, as those skilled in the art know, are very similar to those of QPSK. There is absolutely nothing random or pseudo-random about the communications alphabet used by GSM in order to map information that is to be transmitted into a sequence of symbols. GSM uses a deterministic/predetermined set of constellation points as its communications alphabet, NOT a set of pseudo-random waveforms that have been generated responsive to a statistical distribution....
>
> *Similarly to GSM, CDMA uses a deterministic/predetermined constellation of points (typically Binary Phase Shift Keying or "BPSK" but also, in some cases, QPSK and/or QAM) for its communications alphabet* in order to map information to be transmitted into a sequence of symbols to be transmitted.

('115 Prosecution History, Request for Reconsideration at ODY_DEFS_00000300-301 (May 3, 2011) (emphasis added).)

English

> In the *English language*, for example, the communications alphabet includes the letters A-Z.... *[T]here is nothing pseudo-random about any element of the communications alphabet of the English language. As we all know, each element of the alphabet (i.e., each letter from A to Z) is predetermined, invariant and recognized identically by all who have knowledge of the English language.*

(‘115 Prosecution History, Request for Reconsideration at ODY_DEFS_00000299 (May 3, 2011) (emphasis added).)

112. In these passages, Odyssey is saying that the prior art systems used conventional symbol-by-symbol signaling (QPSK, QAM, BPSK, QPSK; QAM in the prior art CDMA mobile telephone system and GMSK in the prior art GSM mobile telephone system) whereby bit sequences are sequentially mapped onto deterministic amplitude/phase combinations, that is, onto a symbol alphabet.

113. In contrast, Odyssey’s signaling alphabet uses U(nT) elements in a block orthogonal signaling technique. Specifically, in the patents-in-suit, each signal (which Odyssey calls a waveform) is drawn from a signal alphabet (which Odyssey calls a waveform alphabet) consisting of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms.

114. Second, Odyssey distinguished generating a pseudo-random signaling alphabet from random or pseudo-random features of other steps in the transmit chain. (*E.g.*, ‘115 Prosecution History, Remarks at ODY_DEFS_00000503 (May 24, 2010) (activities such as “bit-space encoding, mapping the coded bits into channel symbols and modulating these symbols into a channel” did not describe or suggest “generat[ing] a communications waveform based upon at least one waveform element of the communications alphabet”).)

115. For example, Odyssey stated that using conventional schemes to transmit information has “nothing to do with” generating and using a pseudo-

random signaling alphabet, even though information can have random properties:

> However, *when the alphabet of QPSK is used to transmit information, the information that is transmitted does comprise randomness even though the alphabet of QPSK is entirely deterministic. This randomness has nothing to do with the alphabet or the elements thereof,* but stems from the unpredictable (not predetermined and not known a priori) sequence of alphabet elements that is selected and transmitted responsive to the information that is to be transmitted.

('115 Prosecution History, Request for Reconsideration at ODY_DEFS00000300 (May 3, 2011) (emphasis added).)

> It is also a fact, however, that when one uses the English alphabet to convey information (by speaking or writing) the information that is being conveyed does comprise a random nature (is not predetermined) simply because that which is predetermined (or is devoid of randomness) is incapable of conveying any information (this is a basic principle of information theory in accordance with Shannon). Thus, *even though there is nothing random (or pseudo-random) about any element of an alphabet, when the alphabet is used to communicate information, the information that is being communicated (the sequence of alphabet elements that is being transmitted in order to convey the information) must necessarily comprise randomness.* Accordingly, it is possible for information that is being transmitted/conveyed to comprise randomness while a communications alphabet that is being used in transmitting/conveying the information to be purely deterministic.

('115 Prosecution History, Request for Reconsideration at ODY_DEFS_00000299 (May 3, 2011) (emphasis added).)

116. That is, Odyssey, argued that, although the data of the prior art systems may have random properties, modulating random data does *not* make the resulting signals pseudo-random. Rather, the signals in the waveform alphabet are created to

be random *before* the application of the data.

117. Third, Odyssey argued that conventional systems teach away from using orthogonal signaling alphabets:

> [A]s is clearly stated in Paragraph [0030] of Gorokhov, *communications alphabets containing non-orthogonal elements, such as 8-PSK and 2_k-QAM with k≥2 ... clearly teaches away from the teachings of the present Application* ... [in which] the communications alphabet comprises a plurality of waveform elements that are orthogonal and statistically independent therebetween.

('115 Prosecution History, Remarks at ODY_DEFS_00000505 (May 24, 2010) (emphasis added); *see also* '115 Prosecution History, Remarks at ODY_DEFS_00000405 (Oct. 12, 2010) (arguing that use of "two orthogonal BPSK modulated carriers ... says nothing about any communications alphabet," because "the Examiner is confusing/mixing properties of information that is transmitted with properties of a communications alphabet used in transmitting the information (the two are different and distinct for QPSK, as we have seen)").) In addition, Odyssey's description of the teachings of the present Application as having statistically independent waveform elements further emphasizes the importance of the pseudo-random characteristics of the claimed waveforms. Statistically independent waveform elements are random enough that one waveform element cannot be inferred from any other waveform element.

118. Odyssey also made arguments regarding the patents' signaling alphabet in prosecuting its first non-provisional application that included the XG-CSSC disclosure. (U.S. Application Serial No. 12/372,354 (filed Feb. 17, 2009).)

119. As with the '115 application, the claims in the '354 application includes differences from the claims at-issue in this case. Again, Odyssey made many statements relating to its alleged invention as a whole based on the common portions of the specifications shared by the earlier applications and the patents-in-

suit. For example, in response to rejections from the Examiner, Odyssey emphasized the distinction between cyclostationary and non-cyclostationary signals, arguing that the XG-CSSC disclosure's use of pseudo-randomly generated phase components for the elements of the signaling alphabet decreases cyclostationarity:

> *As is well known, a cyclostationary feature of a signal relates to a repetitive aspect of the signal.* This repetitive aspect of the signal, may be used in detecting presence of said signal even though the signal may be "buried" well below ambient noise. For example, conventional direct-sequence spread-spectrum signals (i.e., CDMA signals) comprise a cyclostationary feature/signature owing to the repetitive nature of "chipping" which is intrinsic to conventional direct-sequence spread-spectrum signals in order to achieve the spreading.

('354 Prosecution History, Remarks at ODY_DEFS_00000952-953 (Oct. 12, 2010) (emphasis added).)

> [E]ach signal that is used to form a symbol (or element) of the communications alphabet includes multiple amplitude components and multiple phase components. Each one of the multiple phase components of each one of the multiple frequency domain signals that is used in forming an element/symbol of the communications alphabet is pseudo-randomly determined. Thus, *each signal that will eventually form a symbol of the communications alphabet includes a plurality of amplitude components and a respective plurality of pseudo-randomly chosen phase components. These signals are then transferred from the frequency domain to the time domain....*
>
> *What are the characteristics of this alphabet? First, each member thereof is a waveform that is pseudo-randomly generated due to the pseudo-random assignment of the phase components associated therewith.* Moreover, at least two of these pseudo-random waveforms are orthogonal to one another due to the orthogonalizing.

> Thus, at least two symbols of the communications alphabet are pseudo-randomly generated waveforms that are orthogonal therebetween. *The pseudo-random waveforms have reduced cyclostationarity because they do not include any repetitive/periodic feature.* Various combinations/sequences of the waveforms in the alphabet, corresponding to information that is to be transmitted/received, are then transmitted/received.

('354 Prosecution History, Remarks at ODY_DEFS_00000953 (Oct. 12, 2010) (emphasis added).)

120. Odyssey also expressly distinguished OFDM from the patents' signaling alphabet on the grounds that OFDM uses cyclostationary signals:

> Moreover, *since Larsson relates to OFDM, the OFDM signal is clearly highly cyclostationary*, since each one of the plurality of OFDM subcarriers is a QPSK or QAM modulated carrier, which comprises a definite cyclostationary property/signature.

('354 Prosecution History, Remarks at ODY_DEFS_00000958 (Oct. 12, 2010) (emphasis added).)

> [T]he waveforms that Larsson is concerned with (i.e., OFDM modulated waveforms) are *highly cyclostationary*.

('354 Prosecution History, Remarks at ODY_DEFS_00000958 (Oct. 12, 2010) (emphasis added).)

121. In these passages, Odyssey reiterates that the pseudo-random waveforms used in the patent are *not* made so by the application of random data such as QAM is used in OFDM systems (a type of parallel frequency channel system). Furthermore, Odyssey is stating that prior art uses of IFFTs, such as in OFDM, produce waveforms that are highly cyclostationary, whereas in the Odyssey patent, pseudo-random, non-cyclostationary waveforms are orthogonalized to create an alphabet of pseudo-random waveforms.

122. Following prosecution of the '115 and '354 applications, Odyssey

continued filing applications, some of which resulted in the patents-in-suit. While prosecuting these later applications, Odyssey did not change the positions described above that it argued to the Patent Office. A high-level description of the prosecution histories of the patents-in-suit is provided in Exhibit A.

123. In sum, it is my opinion that the term "U(nT)" does not have an ordinary and customary meaning independent of the patents-in-suit. Instead, the patents-in-suit consistently and uniformly describe that term as referring to a waveform within a specific type of signaling alphabet intended to create covert communication signals. Specifically, the patents-in-suit are all based on creating a signaling alphabet consisting of sets of digital samples with non-cyclostationary, pseudo-random, and orthogonal and/or orthonormal signal elements. Odyssey also confirmed the scope of the patents' signaling alphabet during prosecution of the applications that preceded the patents-in-suit.

124. Accordingly, a person of skill viewing the entire record would understand the term "U(nT)" as referring to a waveform within a signaling alphabet consisting of pseudo-random, non-cyclostationary, and orthogonal and/or orthornormal waveforms.

B. "mapping by the processor the information symbol sequence $\{I_k\}$ into a waveform sequence $\{U_k(nT)\}$" and related terms (Terms 19-24) – '940 and '169 Patents

125. I understand that the chart below indicates the parties' competing proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"mapping by the processor the information symbol sequence $\{I_k\}$ into a waveform sequence $\{U_k(nT)\}$" (Term 19)	"assigning by the processor each symbol in a symbol sequence $\{I_k\}$ to a corresponding one of M waveforms of the	Odyssey maintains that this claim term should not be governed by 35 U.S.C. §112(6). This claim term should be afforded its

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
	waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence"	plain and ordinary meaning. However, should the Court decide that this claim term should be governed by 35 U.S.C. § 112(6), then Odyssey identifies the following as the structure(s), act(s), or materials corresponding to this claim term. Function: Same as claim language Acts: assigning each symbol in a symbol sequence {Ik} to a corresponding waveform, wherein the resulting sequence of waveforms is a waveform sequence {Uk(nT)} and equivalents thereof
"mapping by the processor the information symbol sequence $\{I_k\}$ into a baseband waveform sequence $\{U_k(nT)\}$" (Term 20)	"assigning by the processor each symbol in a symbol sequence $\{I_k\}$ to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence"	Plain meaning
"mapping by the transmit processor the information symbol sequence $\{I_k\}$ that is to be transmitted into a baseband waveform sequence $\{U_k(nT)\}$"	"assigning by the transmit processor each symbol in a symbol sequence $\{I_k\}$ that is to be transmitted to a corresponding one of M waveforms of the baseband waveform	Plain meaning

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
(Term 21)	alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence"	
"wherein the transmit processor is configured ... to map the information symbol sequence $\{I_k\}$ that is to be transmitted into a baseband waveform sequence $\{U_k(nT)\}$" (Term 22)	"the transmit processor is configured to assign each symbol in a symbol sequence $\{I_k\}$ that is to be transmitted to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence" **In the alternative:** **Means-plus-function** **Function:** Same as claim language **Structure:** transmit processor configured to assign each symbol in a symbol sequence $\{I_k\}$ that is to be transmitted to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence	Plain meaning
"a processor that is configured ... to map the information symbol sequence $\{I_k\}$ into a waveform sequence $\{U_k(nT)\}$" (Term 23)	"a processor is configured to assign each symbol in a symbol sequence $\{I_k\}$ to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence **In the alternative:** **Means-plus-function**	Plain meaning

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
	Function: Same as claim language **Structure:** processor configured to assign each symbol in a symbol sequence $\{I_k\}$ to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence	
"a processor that is configured to process an input bit sequence {b} to thereby form an information symbol sequence $\{I_k\}$; wherein k=1, 2, . . . ; and to map the information symbol sequence $\{I_k\}$ into a baseband waveform sequence $\{U_k(nT)\}$ (Term 24)	"a processor that is configured to assign each symbol in a symbol sequence $\{I_k\}$ to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence" **In the alternative:** **Means-plus-function** **Function:** Same as claim language **Structure:** processor configured to assign each symbol in a symbol sequence $\{I_k\}$ to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT) \ldots, U_M(nT)\}$ in sequence	Plain meaning

126. These related terms relate to using the patents' signaling alphabet to

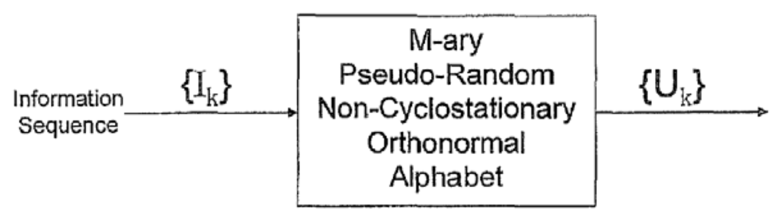
"map" information onto waveforms.

127. Odyssey offers plain meaning constructions for these terms. But Odyssey's plain meaning construction is mistaken because it fails to account for the words in these terms that were coined in the patents-in-suit, such as "$\{U_k(nT)\}$."

128. Instead, the patents-in-suit make clear that the mapping terms refer to the processor assigning each symbol in the information symbol sequence, defined as "$\{I_k\}$," to a corresponding one of M waveforms of the waveform alphabet, defined as "$\{U(nT)\}$" or "$\{U_1(nT), \ldots, U_M(nT)\}$," in sequence to produce the waveform sequence, defined as "$\{U_k(nT)\}$."

129. Figure 4 shows the patents' "M-ary Pseudo-Random Non-Cyclostationary Orthornomal Alphabet" being used to map sequences of information symbols $\{I_k\}$ into sequences of waveforms, defined here as "$\{U_k\}$."

'393 Fig. 4 (excerpt)



130. Similarly, in discussing Figure 4, the patents-in-suit provide an example of the claimed mapping using a specific information symbol and element of the signaling alphabet. The example describes a symbol-to-waveform mapping at the "kth" interval of time. At that time, the information symbol assumes the second of M possible values (I_2). Correspondingly, at that time interval, the second of M waveforms was sent ($U_2(nT)$). This passage shows how information symbols are mapped one-by-one to waveforms from the patents' signaling alphabet.

> [A]n information symbol I_k, occurring at a discrete time k ... and having one of M possible information values, $\{I_1, I_2, \ldots, I_m\}$, may be mapped onto one of the M waveforms

> of the alphabet $\{U_1(nT), U_2(nT), \ldots, U_M(nT)\}$ .... For example, in some embodiments, if $I_k=I_2$, then during the k^{th} signaling interval the waveform $U_2(nT)$ may be transmitted ....

('393 col. 22:41-48.) This process is repeated for each information symbol in the information symbol sequence $\{I_k\}$ to form the waveform sequence $\{U_k(nT)\}$.

131. This passage highlights that the patents use the "I" and "U" nomenclature in an unconventional manner. When "I" includes numbers (or the letter M) as the subscript (*e.g.*, "I_1"), it refers to an element of the set of "M possible information values." (*Id.*) But when "I" includes "k" as the subscript (*e.g.*, "I_k"), it refers to an information symbol at a specific point in time. Similarly, when "U" includes numbers (or the letter M) as the subscript (*e.g.*, "$U_1(nT)$"), it refers to an element of the set of "M waveforms of the alphabet." (*Id.*) But when "U" includes "k" as the subscript (*e.g.*, "$U_k(nT)$"), it refers to a waveform element at a specific point in time. As a result, the set "$\{I_k\}$" refers to the sequence of information symbols over time, and the set "$\{U_k(nT)\}$" refers to the sequence of waveform elements transmitted over time.

132. Figure 7 likewise depicts the "Symbol to Waveform Mapping" step. The information symbol sequence $\{I_k\}$ is converted into a sequence of waveforms $\{U_k(nT)\}$ by mapping each information symbol onto an element of the signaling alphabet shown as "Alphabet 1" in Figure 7:

> As shown in Fig. 7, following conventional operations ... , the information symbol sequence $\{I_k\}$ is mapped onto a non-cyclostationary waveform sequence $\{U_k(nT)\}$ using a first M-ary non-cyclostationary orthonormal alphabet (Alphabet 1).

('393 col. 24:19-27; *see also* '393 col. 23:40-43.)

'393 Fig. 7

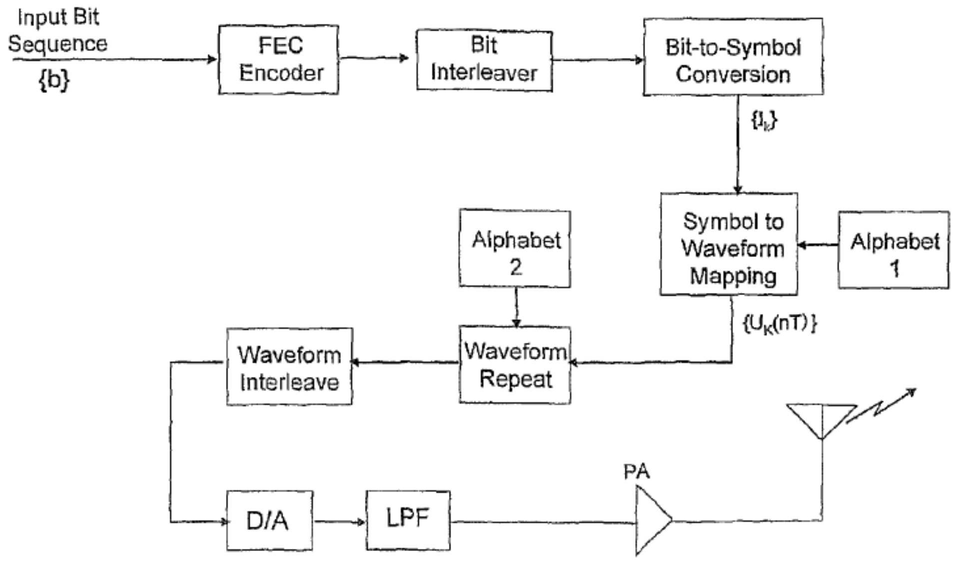


FIGURE 7

133. In the joint claim construction chart, Odyssey cites language from the patents-in-suit indicating that different orderings can be used:

> Furthermore, it will be understood that any unambiguous mapping between the M possible information values of I_k and the M distinct waveforms of the M-ary alphabet, $\{U_1(nT), U_2(nT), \ldots, U_M(nT)\}$, may be used to communicate information to a receiver (destination) provided that the receiver also has knowledge of the mapping. It will also be appreciated that the ordering or indexing of the alphabet elements and the unambiguous mapping between the M possible information values of I_k and the M distinct waveforms of the M-ary alphabet may be arbitrary, as long as both transmitter (source) and receiver (destination) have knowledge of the ordering and mapping.

('393 col. 22:54-65.)

134. This passage simply refers to the ability to have a different one-to-one mapping between the index used to keep track of the information symbols and the index used to keep track of the waveforms in the information alphabet. For

example, instead of mapping the I_1 symbol onto the $U_1(nT)$ waveform element from the waveform alphabet and the I_2 symbol onto the $U_2(nT)$ waveform element from the waveform alphabet, a system could map the I_1 symbol onto the $U_2(nT)$ waveform element and the I_2 symbol onto the $U_1(nT)$ waveform element. But in all cases, the patents require an "unambiguous mapping" between the symbols and the waveforms in the waveform alphabet. ('393 col. 22:54-65.)

135. In sum, a person of skill in the art would recognize that the patents are describing the well-known scheme of block orthogonal signaling. As described in the tutorial, block orthogonal signaling uses M unique signals (the signaling alphabet) that can each correspond to one of M elements in a symbol alphabet, which are in turn, each defined by a set of input bits. As information bits arrive, they are converted into symbols. The symbols are then mapped onto signals from the signal alphabet. In each instance in the patents, the signaling alphabet is used to map one symbol onto a corresponding one waveform from the patents' signaling alphabet. This mapping occurs in sequence, building a waveform sequence $\{U_k(nT))\}$ from the corresponding information symbol sequence $\{I_k\}$.

136. In addition, whether the "processor" term is a means-plus-function limitation is a legal question on which I am not opining. But to the extent that the Court construes the related apparatus terms as means-plus-function limitations, the algorithm performed by the processor would be the same mapping algorithm discussed above. Namely, the processor would assign each symbol in an information symbol sequence $\{I_k\}$ that is to be transmitted to a corresponding one of M waveforms of the baseband waveform alphabet $\{U_1(nT), \ldots, U_M(nT)\}$ in sequence to create the waveform sequence $\{U_k(nT)\}$. The patent does not disclose any other algorithm for performing the function of mapping.

C. "waveform sequence ($U_k(nT)$)" and "waveform sequence ($U_j(iT)$)" (Terms 25-26) – '940 and '169 Patents

137. I understand that the chart below indicates the parties' competing

proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"waveform sequence ($U_k(nT)$)" (Term 25)	"a sequence of waveforms, with each waveform in the sequence chosen from a set of discrete-time, pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms that define a waveform alphabet"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "a waveform sequence wherein k denotes values of discrete time; k = 1, 2, . . . ; for each value of k, n = 1, 2, . . . N"
"waveform sequence ($U_j(iT)$)" (Term 26)	"a sequence of waveforms that is received when $\{U_k(nT)\}$ is transmitted, with each waveform in the sequence chosen from a set of discrete-time, pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms that define a waveform alphabet"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "a waveform sequence wherein j denotes discrete time and wherein for each value of j, i takes on a plurality of values"

138. As described above, the term "$\{U_k(nT)\}$" refers to the sequence of waveforms generated when the information symbol sequence $\{I_k\}$ is mapped onto specific waveform elements from the signaling alphabet $\{U(nT)\}$. For example:

> As shown in Fig. 7, following conventional operations ... , the information symbol sequence $\{I_k\}$ is mapped onto a non-cyclostationary waveform sequence $\{U_k(nT)\}$ using a first M-ary non-cyclostationary orthonormal alphabet (Alphabet 1).

('393 col. 24:1-27; '393 col. 30:45-50.) As I discussed in detail above with respect to Figures 1, 5, and 17, for example, the signaling alphabet consists of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveform elements. As a result, the waveform sequence $\{U_k(nT)\}$ also consists of waveforms with those same features.

139. The term "$U_j(iT)$" is similar to $U_k(nT)$ except that $U_j(iT)$ refers to the signal received by the receiver. For example, '169 claim 1 recites in part:

> A method of conveying information ... , comprising:
>
> ....
>
> radiating by the transmit antenna the baseband waveform sequence $\{U_k(nT)\}$;
>
> receiving by the receive antenna a waveform sequence $\{U_j(iT)\}$ ....

('169 claim 1.)

140. $U_j(iT)$ is a coined term. Although $U_j(iT)$ is not used anywhere in the written descriptions of the patents-in-suit, its use in the claims indicates that it is the signal received when $U_k(nT)$ is transmitted.

141. The term $U_j(iT)$ has the same properties as $U_k(nT)$ except that $U_j(iT)$ is the received signal, rather than the transmitted signal. After the signal is transmitted over the channel, it retains the pseudo-random, non-cyclostationary, and orthonormal properties of the patents' signaling alphabet. If that were not the case,

the receiver could not decode the signal and the signal would not be covert.

D. "waveform alphabet" (Term 27) – '940 and '169 Patents

142. I understand that the chart below indicates the parties' competing proposed constructions for this term:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"waveform alphabet" (Term 27)	"a set of discrete-time, pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "set of waveforms"

143. Odyssey proposes a plain meaning construction for this term, but the claims refer to "waveform alphabet" in the context of the coined term $\{U_k(nT)\}$, the waveform sequence generated using the patents' signaling alphabet $\{U(nT)\}$. For example, '940 claim 5 recites in part:

> A communications method comprising:
>
> ....
>
> ...correlating the waveform sequence $\{U_k(nT)\}$ that is received by the receiver with a plurality of elements of a waveform alphabet ....

('940 claim 5.) For the reasons given above, the received sequence of signals $\{U_k(nT)\}$ consists of pseudo-random, non-cyclostationary, and orthonormal

waveforms. To obtain the information encoded in the received waveform sequence, the waveform alphabet used by the receiver must also necessarily have the features of the received waveform sequence. Thus, the waveform alphabet in the receiver must also consist of pseudo-random, non-cyclostationary, and orthonormal waveforms.

144. Odyssey also proposes, in the alternative, to construe "waveform alphabet" as a "set of waveforms." But an "alphabet" is a set of elements with specific properties, not any set of elements. For example, an alphabet for a spoken language is a set of letters that generally correspond to a set of speech sounds. Similarly, a waveform alphabet refers to a set of elements that correspond to a set of specific information symbols. Thus, contrary to Odyssey's proposed alternative construction, a "waveform alphabet" does not cover all sets of waveforms.

145. Accordingly, for the reasons given above, a person of ordinary skill would understand these terms consistently with Defendants' proposed constructions.

E. "radiating by the transmit antenna the baseband waveform sequence $\{U_k(nT)\}$" and related terms (Terms 28-30) – '940 and '169 Patents

146. I understand that the chart below indicates the parties' competing proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"radiating by the transmit antenna the baseband waveform sequence $\{U_k(nT)\}$" (Term 28)	"directly transmitting the baseband waveform sequence $\{U_k(nT)\}$ without up-conversion"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
		this term, then Odyssey proposes the following construction: "transmitting the baseband waveform sequence $\{U_k(nT)\}$"
"wherein the transmit antenna is configured to radiate the baseband waveform sequence $\{U_k(nT)\}$" (Term 29)	"wherein the transmit antenna is configured to directly transmit the baseband waveform sequence $\{U_k(nT)\}$ without up-conversion"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "wherein the transmit antenna is configured to transmit the baseband waveform sequence $\{U_k(nT)\}$"
"transmitting the baseband waveform sequence $\{U_k(nT)\}$" (Term 30)	"directly transmitting the baseband waveform sequence $\{U_k(nT)\}$ without up-conversion"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning.

147. Although Odyssey offers a "plain meaning" construction for these terms, it seeks to obtain claim scope much broader than the plain claim language.

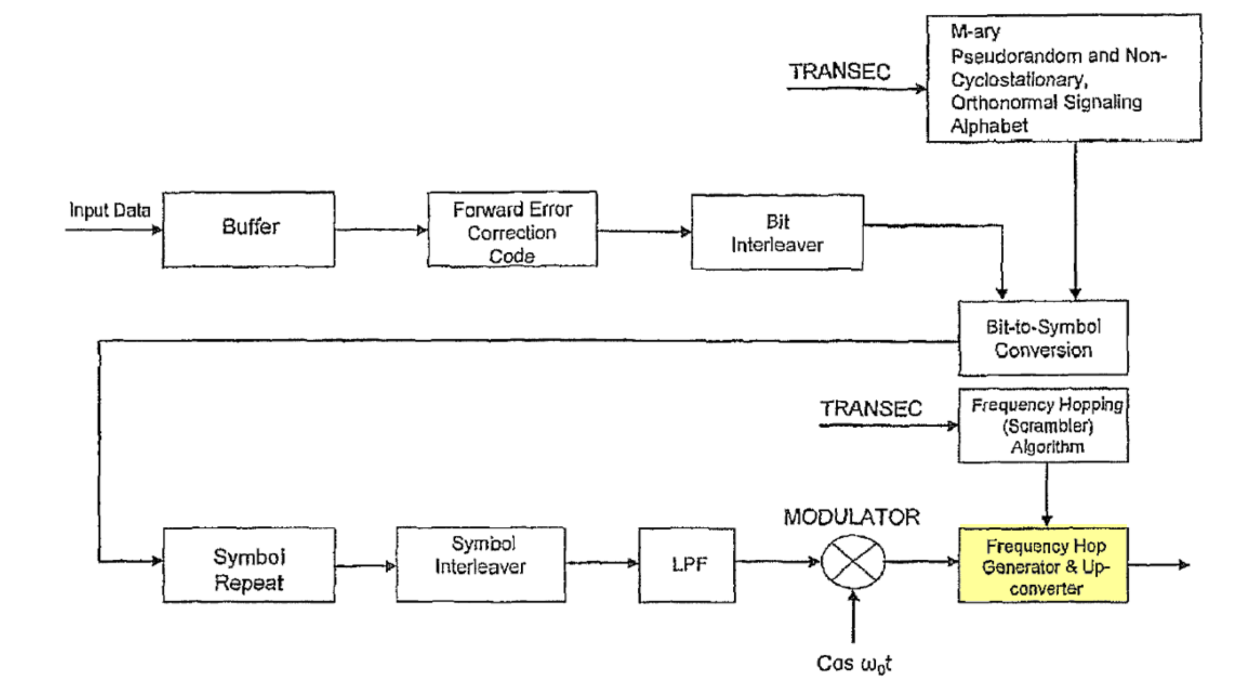
148. "Baseband" is a term with a well-established meaning in this field. Many conventional systems use a process called "up-conversion" to send signals on different channels. Up-conversion converts the frequency of the information signal

into a higher frequency that is then transmitted. The frequency before up-conversion is called the "baseband" frequency and is most often centered around zero. The high frequency after up-conversion is referred to as the "carrier" frequency. By using carriers with different frequencies, signals can be sent in different channels. The receiver performs the inverse process, down-converting the high-frequency carrier signal to the low-frequency baseband signal.

149. Because the claim language recites "*radiating* by the transmit antenna the *baseband* waveform sequence {Uk(nT)}," it requires radiating a signal at the baseband frequency, *i.e.*, radiating a higher-frequency waveform sequence after up-conversion is outside the claim scope.

150. This construction is also fully supported by the specification. The patents describe two different transmission methods. The first method follows the standard practice of up-converting before transmission and is shown in Figure 5. As depicted below, Figure 5 includes a block labeled "Frequency Hop Generator and Up-Converter" used to up-convert the signal from the low baseband frequency to the high carrier frequency.

‘393 Fig. 5 (annotated)

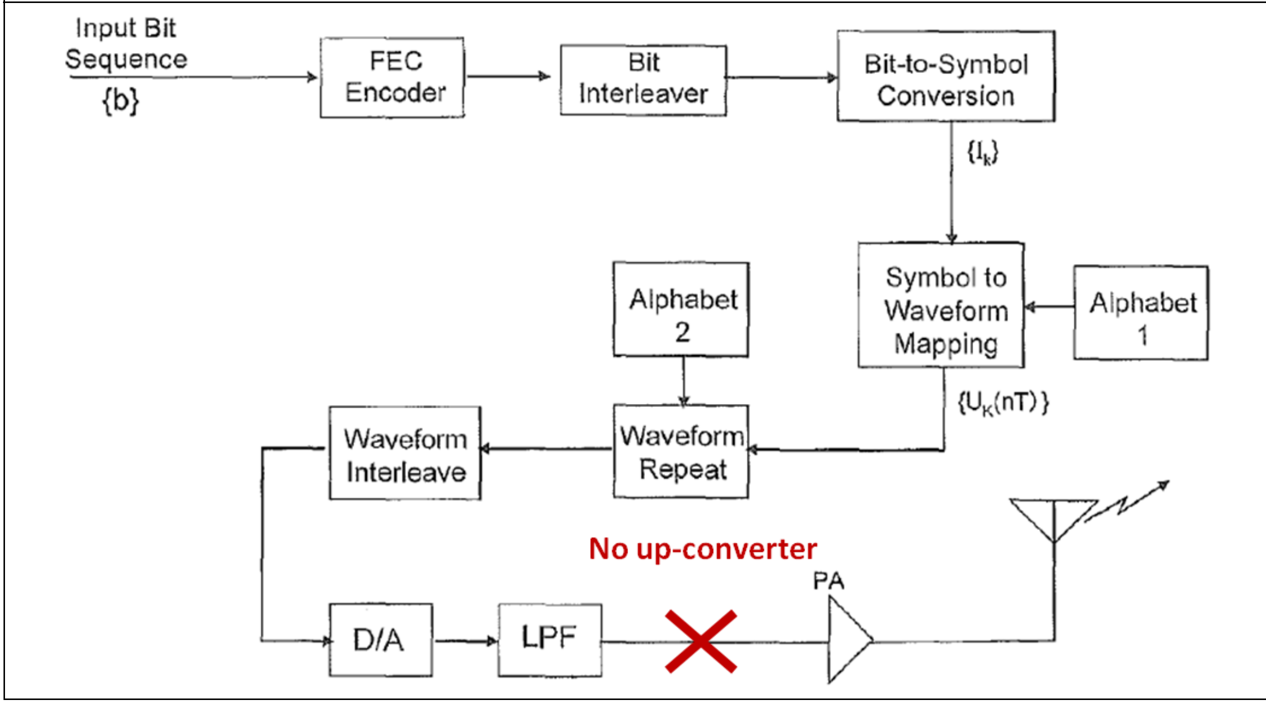


151. In contrast, Figure 7 shows a “direct synthesis” transmitter that sends the baseband signal directly, without up-conversion:

> It will be appreciated that the transmitter embodiment of FIG. 7 illustrates a “direct synthesis” transmitter in that the transmitter directly synthesizes a transmitted waveform, without resorting to up-conversion and/or carrier modulation. This aspect may further enhance the LPI/LPD/LPE feature(s) of a communications system.

(‘169 col. 8:21-27.)

'393 Fig. 7 (annotated)



152. In communications with the government seeking grants, the named inventor elaborated on the statement in the patents that using direct synthesis may increase the covert nature of the signals.

153. In a document titled "Response of EICES Research, Inc. to: Air Force Topic AF131-049 of SBIR Program Solicitation FY 13.1," EICES described the direct synthesis transmission method:

> **EMISSIONS DEVOID OF CARRIER MODULATION**: The technique of generating the chaotic signaling alphabet can be extended to provide frequency content (of the signaling alphabet) directly over desired RF frequencies, as illustrated in Figure 12. Accordingly, <u>the XG-CSS waveform may be radiated by directly radiating the alphabet elements, without relying on carrier modulation and up-conversion. Such a direct RF synthesis avoids radiating a double sideband carrier with correlated signal attractors between the upper and lower sidebands thereof</u>, as would be the case by first forming the alphabet at baseband, followed by up-

> conversion.... The obvious penalty of direct RF synthesis is capacity reduction (since we lose one dimension in not having the carrier to provide the "I" and the "Q"), but it may be worth the sacrifice if the approach erases sideband attractors (as will be quantified during Phase I).

(ODY0003059 (emphasis in original); ODY003053 ("[T]he over-the-air waveforms may be generated directly absent modulation of a carrier, thus precluding correlation detection between carrier sidebands.").)

154. This passage describes both the potential benefit (avoiding correlation detection via the double sideband carrier) and the cost (capacity reduction) of using the direct synthesis method.

155. Similarly, in Proposal No. D052-019-0085, EICES described what would become Figure 7 in the patents, highlighting that the direct synthesis method radiates the signal at baseband, without upconversion:

> The transmitter embodiment of Figure [7] is a "direct synthesis" transmitter in that it directly synthesizes (*at baseband*) the transmitted waveform, *without resorting to up-conversion and/or carrier modulation*. This aspect further enhances the LPI/LPD/LPE features of the system.

(ODY0003643-44 (emphasis added).)

156. In sum, the claim language, written description, and extrinsic evidence all confirm that these related terms require transmission of the "*baseband* waveform sequence," *i.e.*, a baseband signal that has not been up-converted.

F. "a processor that is configured [1] to provide a frequency content for a waveform by Fourier transforming a signal, [2] to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency and [3] to generate the waveform by inverse Fourier transforming the desired spectrum shape" and related terms (Terms 8-9) – '393 and '606 Patents

157. I understand that the chart below indicates the parties' competing proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"a processor that is configured to provide a frequency content for a waveform by Fourier transforming a signal, to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency and to generate the waveform by inverse Fourier transforming the desired spectrum shape [with a binary waveform]" (Term 8)	"a processor that is configured (1) to identify the frequency content being radiated by other transmitters by subjecting the desired band of frequencies to a Fourier transform, (2) to form a water-filled spectrum shape, and (3) to create a waveform that is one of a set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms by inverse Fourier transforming the desired spectrum shape" **In the alternative:** **Means-plus-function** **Function:** See proposed construction above **Structure:** Circuitry of Fig. 17, including: Power Spectrum Estimator (Fig. 17) to identify frequency content radiated by other transmitters, Water Filling Spectrum Shaper (WFSS), IFFT, Uniformly Distributed Random Phase Generator, and Gram-Schmidt Orthonormalizer, connected as in Fig. 17	Plain meaning
"a processor that is	"a processor that is	Plain meaning

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
configured to provide a frequency content [for a waveform] by Fourier transforming a signal, to form [at baseband] a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency content; and to generate [at baseband] a/the waveform by inverse Fourier transforming the desired spectrum shape" (Term 9)	configured (1) to identify the frequency content being radiated by other transmitters by subjecting the desired band of frequencies to a Fourier transform, (2) to form at baseband a water-filled spectrum shape, and (3) to create a waveform that is one of a set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms by inverse Fourier transforming the desired spectrum shape **In the alternative:** **Means-plus-function** **Function:** See proposed construction above **Structure:** Circuitry of Fig. 17, including: Power Spectrum Estimator (Fig. 17) to identify frequency content radiated by other transmitters, Water Filling Spectrum Shaper (WFSS), IFFT, Uniformly Distributed Random Phase Generator, and Gram-Schmidt Orthonormalizer, connected as in Fig. 17	

158. Odyssey again proposes "plain meaning" for these terms. But these terms do not have a plain meaning to a person of skill in the art. Without consulting the written descriptions for the '393 and '606 patents, a person of skill would not know what providing a frequency content for a waveform refers to or what actions were intended to be within the scope of that claim. Likewise, in the abstract, a person of skill would not know what it would mean to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency content. A person would not know what "desired" referred to or how the spectrum shape was supposed to be different from, but responsive to, the frequency content. Nor would a person of skill understand how a transmitter would need to use the outputs from those steps in generating the waveform.

159. Instead, a person of skill would need to look to the written descriptions to understand the claim scope. These related terms come from claims in the '393 and '606 patents, which provide direct, express, and clear teachings showing the meaning of these terms.

160. These terms relate to the XG-CSSC disclosure, which employs a specific method for creating the patents' signaling alphabet.

161. The XG-CSSC's method for creating the signaling alphabet attempts to take advantage of frequencies that are unused or lightly used by other transmitters and thus minimize the amount of interference. Specifically, the XG-CSSC disclosure attempts to account for the presence of other "incumbent users" by focusing on "frequencies that is/are detected as unused or lightly used":

> For military communications, XG-CSSC combines M-ary orthonormal signaling with chipless spread-spectrum waveforms to provide extreme covertness and privacy. Military wireless networks whose mission is to gather and disseminate intelligence stealthily, in accordance with Low Probability of Intercept (LPI), Low Probability of

> Detection (LPD) and Low Probability of Exploitation (LPE) doctrine, may use XG-CSSC terrestrially and/or via satellite. In situations where armed forces face difficult spectrum access issues, *XG-CSSC may be used to cognitively and covertly utilize spectrum resources at minimal impact to incumbent users*.

('393 col. 29:33-43 (emphasis added).)

> As spectrum usage continues to increase, it may become important to equip networks and user devices with agility *to use opportunistically any portion (or portions) of a broad range of frequencies that is/are detected as unused or lightly used*. A regime is envisioned wherein primary usage of spectrum and secondary (opportunistic) usage of the same spectrum co-exist on a non-interference, or substantially non-interference, basis.

('393 col. 29:46-53 (emphasis added).)

162. These related claim terms include three functions performed by the processor, reciting: "a processor that is configured [1] to provide a frequency content for a waveform by Fourier transforming a signal, [2] to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency and [3] to generate the waveform by inverse Fourier transforming the desired spectrum shape." (*E.g.*, '393 claim 15.)

163. Those recited functions closely track the language describing the XG-CSSC transmitter in the specification and the depiction of the transmitter in Figure 17.

164. The following chart and annotated figure correlate the claim language, the relevant passage from the written description, and Figure 17 using three colors. Those three functions are discussed in further detail below.

Claim Language ('393 claim 15)	**Specification ('393 col. 30:5-44)**
"a processor that is configured [1] to provide a frequency content for a	"[A] Power Spectrum Estimator (PSE) may be used to identify frequency

waveform by Fourier transforming a signal, [2] to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency and [3] to generate the waveform by inverse Fourier transforming the desired spectrum shape"	content being radiated by other transmitters. This may be accomplished by, for example, subjecting a band of frequencies, over which it is desired to transmit information, to a Fast Fourier Transform (FFT). Responsive to the output of the PSE, a "Water-Filling Spectrum Shape" (WFSS) may be formed in the FFT domain. Each element (bin) of the WFSS FFT may be assigned a pseudo-random phase value that may be chosen from (0, 2π). An Inverse Fast Fourier Transform (IFFT) may be applied to the WFSS FFT, as illustrated in FIG. 17, to generate a corresponding Gaussian-distributed discrete-time function.... The process may be repeated M times to produce a set of M independent Gaussian-distributed discrete-time functions.... {S(nT)} may be subjected to a GSO in order to generate a set of M orthonormal waveforms {U(nT)} = {U_1(nT), U_2(nT), ... , U_M(nT)}; n=1, 2, ... , N."

'393 Fig. 17

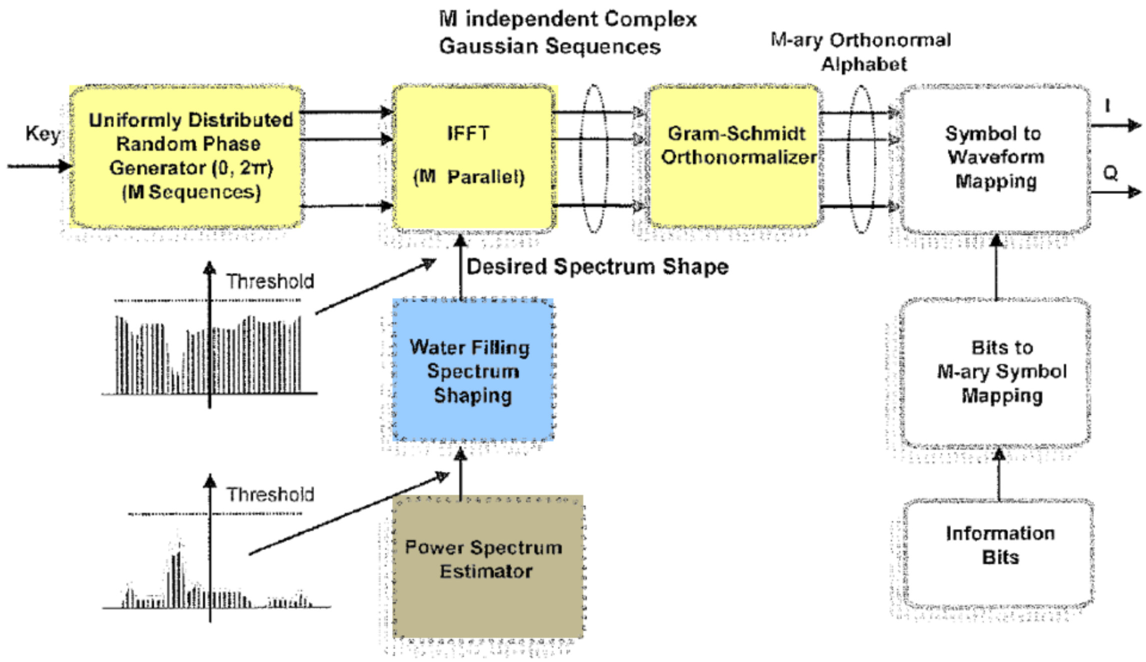


FIGURE 17

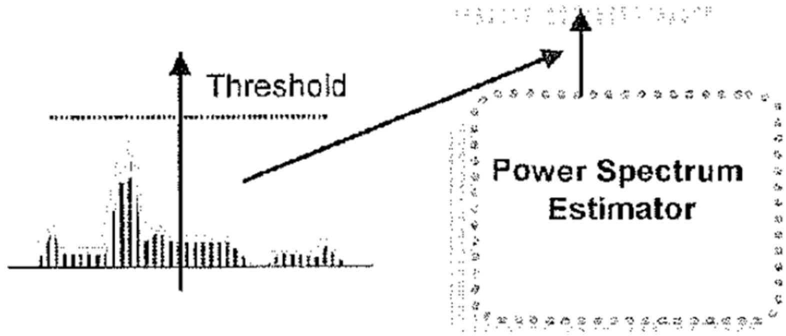
165. ***First***, the bottom-left portion of Figure 17 relates to the first function – "to provide a *frequency content* for a waveform by Fourier transforming a signal." ('393 col. 35:46-47 (emphasis added).) As shown in Figure 17, the transmitter uses a "Power Spectrum Estimator" to "identify *frequency content* being radiated by other transmitters." ('393 col. 30:5-10 (emphasis added).) This step allows the transmitter to determine which frequencies are being heavily used and which are being lightly used.

166. The Power Spectrum Estimator samples the signals radiated by other transmitters and then performs the well-known "Fast Fourier Transform" operation in a specific "band of frequencies" to convert those time-based signals radiated by other users to their frequency-domain representations over that frequency band. ('393 col. 30:5-10.)

167. Figure 17 depicts an example that represents the frequency content generated by the Power Spectrum Estimator as a bar graph, with each bar called a

"bin" or "element." ('393 col. 30:12-13.)

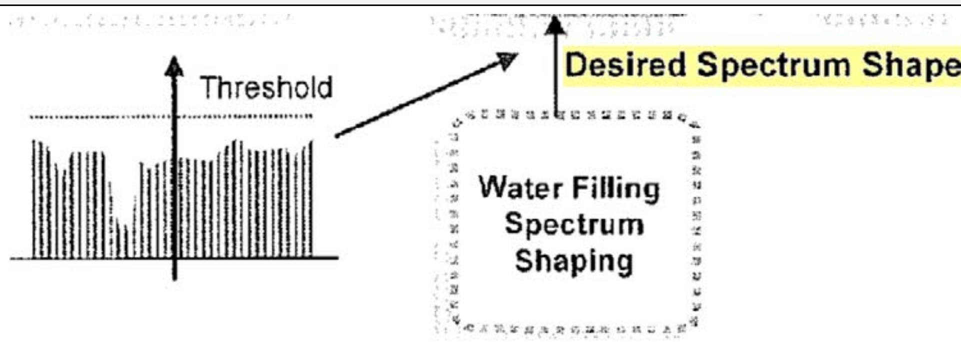
'393 Fig. 17 (excerpt)



168. ***Second***, the next function performed by the claimed processor is "to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency" content. (*E.g.*, '393 claim 15.)

169. This function is shown in the "Water-Filling Spectrum Shaping" step in Figure 17, which expressly defines the output of the water-filling step as the "Desired Spectrum Shape." ('393 Fig. 17, col. 30:10-11.)

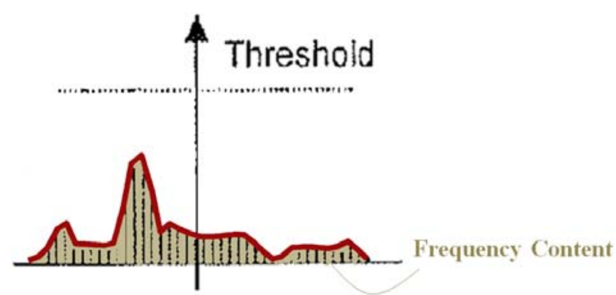
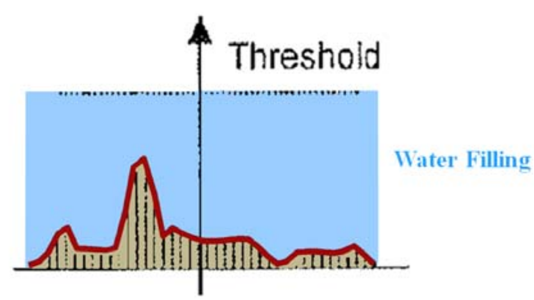
'393 Fig. 17 (excerpt)



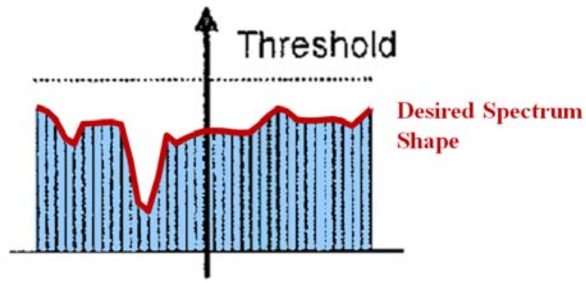
170. As described above in the tutorial, water filling is a long-known tool. Water filling seeks to maximize capacity in a system of parallel channels by allocating more power to channels (or frequency ranges) where the interference is lower and less power to channels where the interference is higher. (Water filling

may allocate no power to high-interference channels if there is insufficient power to allocate some to every channel.)

171. The annotated figure below shows how the water filling in Figure 17 creates a spectrum shape that responds to the shape of the frequency content radiated by other transmitters: "*Responsive to* the output of the PSE, a 'Water-Filling Spectrum Shape' (WFSS) may be formed in the FFT domain." ('393 Fig. 17, col. 30:10-11 (emphasis added).) Figure 17 shows the "Desired Spectrum Shape" as the inverse of the shape of the frequency content, with the desired spectrum shape having a high power level where the power level of the frequency content is low, and vice-versa.

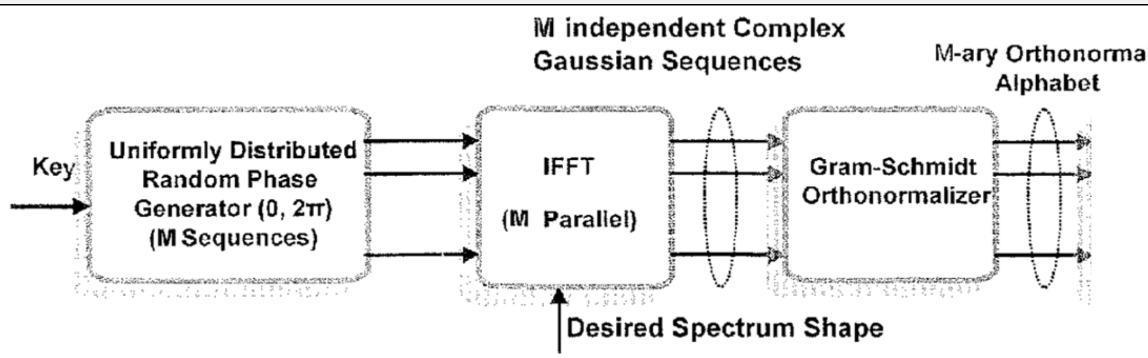
Water-Filling Technique ('393 Fig. 17 (annotated detail))
Generating Frequency Content

Water-Filling


Forming a Desired Spectrum Shape



172. ***Third***, the final function performed by the claimed processor is "to generate the waveform by inverse Fourier transforming the desired spectrum shape." (*E.g.*, '393 claim 15.) Figure 17 shows three blocks used to perform that function.

'393 Fig. 17 (Excerpt)



173. The first block generates M sequences that each include a pseudo-random phase value for each of the frequency bins in the desired spectrum shape. ('393 col. 30:12-13 ("Each element (bin) of the WFSS FFT may be assigned a pseudo-random phase value that may be chosen from (0, 2π).").) The Figure 17 transmitter generates the sequence of pseudo-random values using a key and a "Uniformly Distributed Random Phase Generator." ('393 Fig. 17.) The Desired Spectrum Shape provides each of those random phase values with a weighting.

174. The second block uses the well-known Inverse Fast Fourier Transform (IFFT) to convert each set of weighted random numbers in the frequency domain into a time-domain waveform:

> An Inverse Fast Fourier Transform (IFFT) may be applied to the WFSS FFT, as illustrated in FIG. 17, to generate a corresponding Gaussian-distributed discrete-time function. (The technique is not limited to Gaussian distributions. However, the Gaussian distribution is of particular interest since waveforms that have Gaussian statistics and are devoid of cyclostationary features are substantially indistinguishable from thermal noise.)

('393 col. 30:14-21.) Those steps are performed M times in parallel to create the set of M discrete-time functions labeled as "$S_1(nT)$, $S_2(nT)$, ... , $S_M(nT)$." ('393 Fig. 17, col. 30:21-23, 30:28-30.)

175. Third, the S(nT) functions are passed through the Gram-Schmidt orthonormalizer to create the set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms that make up the patents' signaling alphabet ({U(nT)}). ('393 Fig. 17.)

176. Thus, the written description shows that the three functions recited in the claim correspond to the three sets of blocks from Figure 17 and the accompanying text. Accordingly, a person of ordinary skill reviewing the claim language in light of the specification would conclude that the claims refer to the water-filling method and construe the terms as Defendants have proposed.

177. The prosecution history also supports construing these claims as reciting the water-filling method in the '393 and '606 patents, contrary to Odyssey's purported "plain meaning" construction.

178. During prosecution, Odyssey did not claim to have invented all uses of Fourier Transforms and Inverse Fourier Transforms in transmitting information. Instead, Odyssey acknowledged that Fourier Transforms and Inverse Fourier Transforms have long been used in the art for a variety of purposes.

179. For example, Odyssey distinguished the XG-CSSC disclosure from a patent publication called Larsson in three ways relevant for these disputed claim terms. (Larsson, U.S. Pub. No. 2009/0168844.) First, Odyssey argued that conventional OFDM steps—such as using an Inverse Fast Fourier Transform (IFFT) to modulate the data bits onto OFDM subcarriers—have "nothing to do" with the patents' use of an IFFT in forming a signaling alphabet:

> Consistent with the explanation provided above, Larsson explains that data bits are received and then encoded by forward error correction, punctured, interleaved and repeated, and then are mapped to modulation symbols by a symbol modulator. The modulated symbols are also referred to as subcarriers. As shown by the last above underlined passage of Paragraph [0028], an IFFT is used to transform blocks of symbols from the frequency domain to the time domain waveform, so that it can be transmitted. *However, this conversion has nothing to do with the formation of a communications alphabet. Rather, data bits from a communications alphabet are already received in the first above underlined passage and these data bits are encoded, punctured, interleaved and repeated. The frequency domain to time domain conversion has to do with the modulation of the data bits onto OFDM subcarriers.*

('354 Prosecution History, Remarks at ODY_DEFS_00000957-958 (Oct. 12, 2010) (emphasis added).)

180. Second, Odyssey argued that orthogonalization of OFDM subcarriers has "nothing to do" with the patents' orthogonalizing of pseudo-random signals in a communications alphabet:

> However, before leaving the analysis of Larsson, please note that *any orthogonalizing that may be performed in Larsson is performed to create orthogonal OFDM subcarriers, but has nothing to do with orthogonalizing random signals to create elements/symbols of a communications alphabet.*

(‘354 Prosecution History, Remarks at ODY_DEFS_00000958 (Oct. 12, 2010) (emphasis added).)

181. Third, Odyssey stated that Larsson used pseudo-random phase shifts to reduce peaks in the frequency spectrum, not to create a communications alphabet:

> Paragraph [0038] explains that *the phase of the OFDM subcarriers is varied, randomly or deterministically, to reduce peaks in the frequency spectrum*. Thus, the modulated OFDM subcarriers are phase shifted. However, there is no description or suggestion that a random value is assigned to each phase component of a plurality of phase components of each one of the plurality of frequency domain signals that is used to form a communications alphabet, as recited in Claim 22. Moreover, *in Larsson, randomization is performed in order to reduce peaks in the frequency spectrum of the modulated waveform, and not in order to form a communications alphabet*.

(‘354 Prosecution History, Remarks at ODY_DEFS_00000956 (Oct. 12, 2010) (emphasis added).)

> *This passage makes it clear that phase shifts are being applied to individual subcarriers of a modulated OFDM signal rather than to each phase component of a plurality of phase components of each one of a plurality of frequency domain signals*, in order to establish a communications alphabet, as recited in Claim 22.

(‘354 Prosecution History, Remarks at ODY_DEFS_00000957 (Oct. 12, 2010) (emphasis added).)

> Accordingly, *Larsson has nothing to do with forming a communications alphabet*, but, rather, relates to improvements of OFDM modulation efficiency.

(‘354 Prosecution History, Remarks at ODY_DEFS_00000956 (Oct. 12, 2010) (emphasis added).)

182. Thus, Odyssey made clear during prosecution that its alleged invention

did not extend to other uses of IFFTs, such as the use of IFFTs to modulate data onto OFDM subcarriers, or measures to improve modulation efficiency.

183. Following prosecution of the '354 application, Odyssey continued filing applications, some of which resulted in the patents-in-suit. During the prosecution of these later applications, Odyssey did not change the positions it had previously argued to the Patent Office. As noted above, a high-level description of the prosecution histories of the patents-in-suit is provided in Exhibit A.

184. In sum, these disputed terms claim a specific way of generating the patents' signaling alphabet. The transmitter determines the interference power level at various frequencies and applies water filling to determine the amount of power to be allocated to each frequency, thereby shaping the spectrum of the various signals in the signal alphabet. The signals $S_1(nT)$, ... , $S_M(nT)$ are generated by combining the power allocations with random phases and then performing an Inverse Fast Fourier Transform. These signals are then converted into a set of orthonormal signals that make up the signaling alphabet {U(nT)} by the well-known Gram-Schmidt orthonormalization procedure. ('393 col. 21:46-49.) Notably, all of the steps described above are performed in creating the signaling alphabet. Using the signaling alphabet to map information symbol sequences into a waveform sequence occurs *after* those steps.

185. In addition, if the Court construes these related terms as means-plus-function limitations, the three recited functions should be construed as proposed by Defendants for the reasons described above. The structure disclosed in the patents-in-suit as corresponding to those functions is depicted in Figure 17. Specifically, the structure necessary for performing those three functions is the structure to the left of the "M-ary Orthonormal Alphabet" in Figure 17. As detailed above, the Power Spectrum Estimator is necessary to measure the frequency content of the other transmitters, the Water Filling Spectrum Shaper is necessary to create the desired spectrum shape, and the remaining blocks are necessary to generate the

pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms that make up the patents' signaling alphabet.

G. "providing a frequency content for a waveform by Fourier transforming a signal" and related terms (Terms 1-2) – '393 and '606 Patents

186. I understand that the chart below indicates the parties' competing proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"providing a frequency content for a waveform by Fourier transforming a signal" (Term 1)	"identifying the frequency content being radiated by other transmitters by subjecting the desired band of frequencies to a Fourier transform"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "Providing a frequency content for a waveform by performing a Fourier transform on a signal"
"providing a frequency content by Fourier transforming a signal" (Term 2)	"identifying the frequency content being radiated by other transmitters by subjecting the desired band of frequencies to a Fourier transform"	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
		"Providing a frequency content by performing a Fourier transform on a signal"

187. These related terms claim the same scope as the first function discussed above for Term 8. For example, the language from Term 1 – "providing a frequency content for a waveform by Fourier transforming a signal" – closely tracks the language from Term 8 – "provide a frequency content for a waveform by Fourier transforming a signal."

188. Accordingly, for the reasons given above, a person of ordinary skill would understand these terms consistently with Defendants' proposed constructions.

H. "forming a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency content" (Term 3) – '393 and '606 Patents

189. I understand that the chart below indicates the parties' competing proposed constructions for this term:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"forming a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency content" (Term 3)	"forming a water-filled spectrum shape"	Plain meaning

190. This term claims the same scope as the second function discussed

above for Term 8. For example, the language from Term 3 – "forming a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency content" – closely tracks the language from Term 8 – "to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency" content.

191. Accordingly, for the reasons given above, a person of ordinary skill would understand these terms consistently with Defendants' proposed constructions.

I. "forming at baseband a desired spectrum shape" and related terms (Terms 4, 10) – '230 Patent

192. I understand that the chart below indicates the parties' competing proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"forming at baseband a desired spectrum shape" (Term 4)	"forming at baseband a water-filled spectrum shape or a power spectral density over a range of frequencies that substantially excludes certain frequency intervals in that range from providing frequency content"	Plain meaning
"a processor that is configured to form at baseband a desired spectrum shape and to generate at baseband a waveform responsive to the desired spectrum shape" / "a processor that is configured to form at	"a processor that is configured (1) to form at baseband a water-filled spectrum shape or a power spectral density over a range of frequencies that substantially excludes certain frequency	Plain meaning

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
baseband a desired spectrum shape ... and to generate the waveform at baseband responsive to the desired spectrum shape" (Term 10)	intervals in that range from providing frequency content and (2) to create at baseband a waveform that is one of a set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms responsive to the desired spectrum shape **In the alternative:** **Means-plus-function** **Function:** See proposed construction above **Structure:** Circuitry of Fig. 17, including: Water Filling Spectrum Shaper (WFSS), IFFT, Uniformly Distributed Random Phase Generator, and Gram-Schmidt Orthonormalizer, connected as in Fig. 17	

193. Odyssey again proposes a "plain meaning" construction for these terms. A person of skill, however, would not understand these terms as having a customary meaning independent of the '230 patent from which they arise. Instead, as described above, without looking at the '230 specification, a person of ordinary skill would not know what "desired" referred to or how to achieve a "desired spectrum shape."

194. These related claim terms from the '230 patent use different language from the shaping language discussed above for the '393 and '606 patents. Term 4

recites "forming at baseband a desired spectrum shape," whereas the relevant portion of Term 8 recites "to form a desired spectrum shape for the waveform, that differs from the frequency content, responsive to the frequency" content.

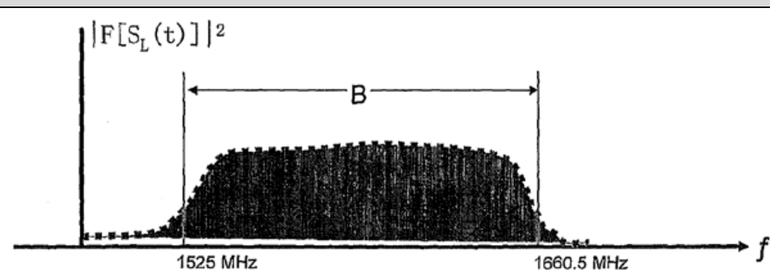
195. The language used by Term 4 is broad enough to include the shaping step performed in the XG-CSSC disclosure. Because the '230 patent includes the XG-CSSC disclosure, it is my opinion that a person of skill would interpret Term 4 as including that scope.

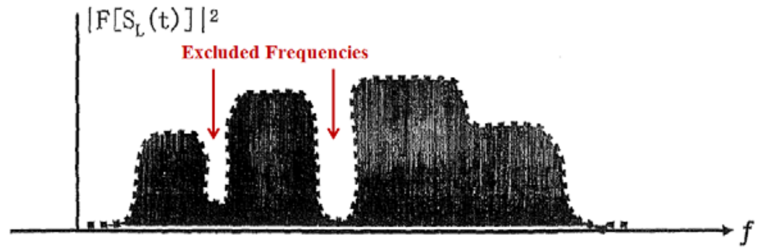
196. Term 4 is also potentially broader, because it does not also require that the desired spectrum shape be different from, but responsive to, the measured frequency content. In addition to the XG-CSSC disclosure, the '230 patent includes a brief discussion of excluding certain frequency ranges due to expected interference, giving GPS as an example. Specifically, in one figure and a paragraph, the '230 patent states that certain frequencies may be excluded from being used in generating the signaling alphabet:

> FIG. 8 illustrates a power spectral density of a broadband waveform defining the M-ary non-cyclostationary orthonormal alphabet .... As is further illustrated in FIG. 8 (second trace), certain frequency intervals that warrant protection (or additional protection) from interference, such as, for example, a GPS frequency interval, may be substantially excluded from providing frequency content for the generation of the M-ary non-cyclostationary orthonormal alphabets.

('393 Col. 24:46-64.)

'230 Fig. 8 (annotated)



'230 Fig. 8 (annotated)


197. Figure 8 and the accompanying text do not discuss any way of excluding frequency intervals or teach a person of skill how to do so and, therefore, do not describe or enable a claim covering that embodiment.

198. Nevertheless, for purposes of claim construction, it is my opinion that a person of skill reading that claim language in light of the '230 patent would interpret the phrase "forming at baseband a desired spectrum shape" to include both water filling from Figure 17 and using a power spectral density that excludes certain frequency intervals from providing frequency content from Figure 8.

199. To the extent the Court construes Term 10 as a means-plus-function limitation, the scope of the claim would be narrower. Because Figure 8 does not describe any structure that could form that desired spectrum shape, the claim cannot be afforded that scope. Thus, the scope would be limited to the same structures as the corresponding language in Term 8, the structures in Figure 17.

200. Finally, Term 10 includes claim language requiring generation of the waveforms making up the patents' signaling alphabet. For the reasons given above, that language would take on the same scope as Term 8.

J. "forming a desired spectrum shape for a waveform" and related terms (Terms 6, 12) – '837 Patent

201. I understand that the chart below indicates the parties' competing proposed constructions for these related terms:

Term	**Defendants' Proposed Construction**	**Plaintiff's Proposed Construction**
"forming a desired spectrum shape for a waveform" (Term 6)	"forming a power spectral density over a range of frequencies that substantially excludes certain frequency intervals from providing frequency content"	Plain meaning
"a processor that is configured to form a desired spectrum shape for a waveform and to generate the waveform responsive to the desired spectrum shape" (Term 12)	"a processor that is configured (1) to form a power spectral density over a range of frequencies that substantially excludes certain frequency intervals from providing frequency content and (2) to create a waveform that is one of a set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms responsive to the desired spectrum shape" **In the alternative:** **Means-plus-function** **Function:** See proposed language above **Structure:** Indefinite	Plain meaning

202. These related claim terms from the '837 patent (Terms 6 and 12) include language similar to Terms 4 and 10 from the '230 patent discussed above.

203. A major distinction, however, exists between the two patents.

Whereas the '230 patent includes the XG-CSSC disclosure, the '837 patent does not. Instead, in filing the application that led to the '837 patent, Odyssey expressly and intentionally removed the XG-CSSC disclosure from the application. (*See* Exhibit A.) The '837 patent, however, does include the GPS embodiment from Figure 8 discussed above.

204. Thus, in my opinion, a person of skill reviewing the patents and prosecution histories would conclude from Odyssey's removal of the XG-CSSC disclosure from the '837 patent that Odyssey did not intend to cover the XG-CSSC disclosure with the language. Instead, a person of skill reading the claim language in light of the '837 patent's more limited disclosure and the express statements in the '837 prosecution history would conclude that the phrase "forming a desired spectrum shape for a waveform" as used in the '837 patent covers only using a power spectral density that excludes certain frequency intervals from providing frequency content.

205. To the extent the Court construes Term 12 as a means-plus-function limitation, the claim is indefinite. As noted above for Term 10, Figure 8 does not describe any structure for performing the function of excluding certain frequencies from providing a frequency content. Because the '837 patent does not disclose any structure for performing the recited function, a means-plus-function construction would render the claims including Term 12 invalid for indefiniteness.

206. In addition, Term 12 includes claim language requiring generation of the waveforms making up the patents' signaling alphabet. For the reasons given above, that language would take on the same scope as the corresponding language in Term 8.

K. "generating the waveform by inverse Fourier transforming the desired spectrum shape" and related terms (Terms 15-18) – '393, '606, '230, and '837 Patents

207. I understand that the chart below indicates the parties' competing

proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"generating the waveform by inverse Fourier transforming the desired spectrum shape" (Term 15)	"creating a waveform that is one of a set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms by inverse Fourier transforming the desired spectrum shape" **In the alternative for apparatus claims:** See proposed constructions for same claims	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: produc[ing] a waveform
"generating at baseband a waveform by inverse Fourier transforming the desired spectrum shape" (Term 16)	"creating at baseband a waveform that is one of a set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms by inverse Fourier transforming the desired spectrum shape" **In the alternative for apparatus claims:** See proposed constructions for same claims	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "produc[ing] at baseband [a] waveform by inverse Fourier transforming the desired spectrum shape"
"generat[ing] at baseband [a] waveform responsive to the desired spectrum shape" (Term 17)	"a processor that is configured to create at baseband a waveform that is one of a set of pseudo-random, non-	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
	cyclostationary, and orthogonal and/or orthonormal waveforms responsive to the desired spectrum shape" **In the alternative for apparatus claims:** See proposed constructions for same claims	meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "produc[ing] at baseband [a] waveform responsive to the desired spectrum shape"
"generat[ing] [the] waveform responsive to the desired spectrum shape" (Term 18)	"a processor that is configured to create at baseband a waveform that is one of a set of pseudo-random, non-cyclostationary, and orthogonal and/or orthonormal waveforms responsive to the desired spectrum shape" **In the alternative for apparatus claims:** See proposed constructions for same claims	Odyssey maintains that no construction is necessary for this term. This claim term should be afforded its plain and ordinary meaning. However, should the Court decide to construe this term, then Odyssey proposes the following construction: "produc[ing] [the] waveform responsive to the desired spectrum shape"

208. These claim terms essentially track the language of the third function of the claimed processor from Term 8. For example, Term 15 recites "generating the waveform by inverse Fourier transforming the desired spectrum shape," and the corresponding function from Term 8 recites "to generate the waveform by inverse Fourier transforming the desired spectrum shape."

209. Accordingly, as discussed above, the "generating" language should be construed to require generating a pseudo-random, non-cyclostationary, and

orthogonal and/or orthonormal waveform as part of generating the patents' signaling alphabet.

210. In addition, to the extent the Court construes the apparatus terms as means-plus-function limitations, the Court should afford the same scope as the corresponding language from Term 8.

L. "selecting a frequency interval over which a waveform U(nT) is to exist; wherein n denotes a discrete time index and wherein n=1, 2, ... , N; allowing at least one frequency that is included in the selected frequency interval to provide a frequency content to the waveform U(nT); excluding at least one frequency that is included in the selected frequency interval from providing a frequency content to the waveform U(nT); forming the waveform U(nT) comprising a plurality of elements U(T), U(2T), ... , U(NT), corresponding to respective integer values 1, 2, ... , N of the discrete time index n" and related terms (Terms 5, 7) – '230 and '837 Patents

211. I understand that the chart below indicates the parties' competing proposed constructions for these related terms:

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
"selecting a frequency interval over which a waveform U(nT) is to exist; wherein n denotes a discrete time index and wherein n=1, 2, . . . , N; T>0; allowing at least one frequency that is included in the selected frequency interval to provide a frequency content to the waveform U(nT); excluding at least one frequency that is included in the selected frequency	"determining the frequencies over which a waveform in a set of pseudo-random, non-cyclostationary waveforms will have content by creating a water-filled spectrum shape or a power spectral density over a frequency interval that substantially excludes certain frequency intervals from providing frequency content"	Plain meaning

Term	Defendants' Proposed Construction	Plaintiff's Proposed Construction
interval from providing a frequency content to the waveform U(nT)" (Term 5)		
"selecting a frequency interval over which a waveform U(nT) is to exist; wherein n denotes a discrete time index and wherein n=1, 2, . . . , N; allowing at least one frequency that is included in the selected frequency interval to provide a frequency content to the waveform U(nT); excluding at least one frequency that is included in the selected frequency interval from providing a frequency content to the waveform U(nT); forming the waveform U(nT) comprising a plurality of elements U(T), U(2T), ... , U(NT), corresponding to respective integer values 1, 2, ... , N of the discrete time index n" (Term 7)	"determining the frequencies over which a waveform in a set of pseudo-random, non-cyclostationary waveforms will have content by creating a power spectral density over a frequency interval that substantially excludes certain frequency intervals from providing frequency content"	Plain meaning

212. Odyssey again proposes a "plain meaning" construction for these terms. A person of skill, however, would not understand these terms as having a customary meaning independent of the patents from which they arise. Instead, as detailed above for example, the term "U(nT)" is a coined term defined in the patent as referring to waveforms with specific characteristics, as shown in Figure 1.

213. These related claim terms from the ‘837 and ‘230 patents (Terms 5 and 7) are similar but their appropriate scope differs due to the differences in the disclosures between the ‘837 and ‘230 patents. Whereas the ‘230 patent includes the XG-CSSC disclosure, the ‘837 patent does not and, a person of skill reviewing the patents and prosecution histories would conclude from Odyssey’s removal of the XG-CSSC disclosure from the ‘837 patent that Odyssey did not intend to cover the XG-CSSC disclosure with the language. Instead, a person of skill reading the claim language in light of the ‘837 patent’s more limited disclosure and the express statements in the ‘837 prosecution history would conclude that this claim term was limited to the disclosure of Fig. 8, already described above.

214. These terms include four steps, which I summarize as: (1) selecting a frequency interval over which U(nT) can exist; (2) allowing frequencies in that interval to provide frequency content for U(nT); (3) excluding certain frequencies within that interval from providing a frequency content for U(nT), and (4) forming the waveform U(nT). Although this claim term differs from many of the related terms described above in that it does not expressly recite forming a desired spectrum shape, it does expressly require “excluding at least one frequency that is included in the selected frequency interval.” The ‘837 patent describes the claimed “frequency content” (e.g., “allowing at least one frequency that is included in the selected frequency interval to provide a frequency content to the waveform U(nT)”) as a “power spectral density.” (‘837 col. 3:48-49, 5:56-57, 9:7-8, 11:24-25.)

215. In the ‘837 patent, only one figure and the short corresponding description relate to the exclusion of certain frequencies from use in generating the signaling alphabet:

> FIG. 8 illustrates a power spectral density of a broadband waveform defining the M-ary non-cyclostationary orthonormal alphabet .... As is further illustrated in FIG. 8 (second trace), certain frequency intervals that warrant protection (or additional protection) from interference,

> such as, for example, a GPS frequency interval, may be *substantially excluded from providing frequency content* for the generation of the M-ary non-cyclostationary orthonormal alphabets.

('393 col. 23:55-24:6 (emphasis added).) There is no other disclosure in the '837 patent related to the steps discussed above.

216. As discussed above with respect to the '230 patent, this figure and passage, however, do not actually discuss any specific way of excluding frequency intervals or teach a person of skill how to do so and, therefore, do not describe or enable a claim covering that embodiment. Nevertheless, for purposes of claim construction, it is my opinion that a person of skill reading the language of Term 7 in light of the '837 patent would interpret the "selecting," "allowing," "excluding," and "forming" steps to mean using a power spectral density that excludes certain frequency intervals from providing frequency content as shown in Figure 8. Given the limited nature of the patent's disclosure, there is no other way to understand this claim language.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct:

Dated: February 25, 2016

Anthony Acampora, Ph.D.